BROOKLYN BOTANIC GARDEN RECORD

PLANTS & GARDENS

HANDBOOK ON GARDENING

ow to Choose
and Grow
lowers, Fruits
Vegetables
House Plants

rden Practices
Illustrated

How to Make
and Care for
a Lawn

Fundamentals
of Landscape
Design

ood Plants for
he Landscape

SPRING
1959

NEW SERIES
15 No. 1

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700 species and varieties of roses grow in the Cranford Memorial Rose Garden of the Brooklyn Botanic Garden; 10,000 blooms can be seen any day during spring and fall

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES
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We hope readers will find this HANDBOOK ON GARDENING a useful guide to better growing. What varieties to plant, and when and where to plant them—are perennial questions, and much of the handbook is devoted to them. But this is not all. Guest Editor Ries and Editor Frese, with their collaborators, have included 42 different topics in the 96 pages that follow. There is a complete section on garden practices, another on lawns, still another on home landscaping. And, finally, there is a section on trees, shrubs and vines—permanent plants in the landscape.

If in doubt about how to prune, how to plant a tree or shrub, how to make compost, or how to organize your vegetable garden—the answers are all here, with some 120 illustrations.

Questions by the thousands: From time to time we like to report on some of the routine jobs we do. Here is one about answering questions.

In the course of an average year, Botanic Garden staff members spend a total of more than 800 hours answering some 10,000 questions by telephone alone. This is the same as having one person in continuous telephone conversation for 5 months of 40-hour weeks. As a public service, it is part of the job our people enjoy doing. About 40 questions are asked over and over again by different people, by letter as well as by phone. For example:

"How do we decide what trees and shrubs to plant on our newly acquired property, and how do we go about making a lawn . . . and flower beds?"

"How do I start a compost pile?"

"How often must I water my house plants . . . and how does one get rid of mealy bugs?"

Whether you are an experienced gardener or an enthusiastic beginner, this HANDBOOK ON GARDENING is designed for you.

Yours sincerely,

George S. Avery

Director

Part I — Plants for Garden and Home

GUIDE TO THE USE OF ANNUALS, PERENNIALS, BULBS

Victor H. Ries

THE desire for color in the garden is best satisfied by the liberal use of annuals, perennials and bulbs in variety. All three classes of plants have their place, because each has its value as to season of bloom, height or mass of color.

Succession of bloom from early spring to late fall is the goal of nearly every gardener. To achieve this consider first that very few hardy flowers have an individual blooming period of more than two or three weeks. Even annuals bloom only during the summer. Therefore, even for a small garden, one may have to select several dozen different kinds of plants to assure bloom from March to killing frost.

Your climate will determine how early in the spring and how late in the fall you can have flowers. An added factor is the location of your garden. Low spots in valleys often suffer more from frosts than those at slightly higher elevation, or on hillsides. This is usually due to lack of air drainage to carry the cold air away. Those near large bodies of water, such as lakes and the ocean, may have a later spring but a longer growing season in the fall than those but a few miles away. Very hot summer climates, especially where the nights are hot, limit the kinds of flowers that may be grown. This applies to hardy flowers as well as annuals.

Planning the Flower Garden

The skillful gardener employs numerous devices to achieve a colorful flower bed or border. For example, by plantin spring flowering bulbs between an beneath other flowers, each square foo of ground should give at least two crop of bloom. Conversely, after spring bulb such as daffodils and tulips, are throug blooming, they may be interplanted wit annuals for summer bloom. As summe blooming annuals go by in Septembe they can be followed by chrysanthemu clumps transplanted from another pa of the garden. An orderly plan, made i advance, will simplify the task of keepin the show going from season to season.

The kinds of flowers you grow will b determined in a measure by the amoun of sunlight available. This will vary fro bed to bed, from one side of the house t the other. Most flowers will thrive in ful sun but a few require shade. Others ar shade tolerant, though doing better wit a greater amount of sunlight. So it i possible to have flowers in the shade o trees, shrubs and buildings even where n direct sunlight reaches. Such plants a ferns, many wild flowers, and begonia have to be protected from the summe sun, for otherwise they may sun-scorch.

When making a plan, it is important to know how tall each kind of flower grows so as not to plant tall growing ones in front of low ones. The habit of growth should be known too, so as not to crowd massive clumps like peonies next to smaller, weaker growers such as peachleaf bellflowers; or sprawling coreopsis next to a low, tufted Japanese primrose. Very

Genereux

Clumps of perennials are the backbone of this border; annuals fill spaces between them

rank growers like the plume poppy and spreading Chinese lantern are really best kept out of beds with other flowers altogether.

Much has been said and written about planning color schemes in the garden. They are fascinating to think about, but often difficult to work out. Do not be disconcerted if the results are not as expected. Flowers have an irritating way of not blooming just when they should, so that carefully planned combinations may not materialize. Colors vary too. Blues in catalogs are not always your idea of blue. This goes for lavender, purple, red, pink, orange, yellow and so on through the rainbow. In any case, there is enough green foliage to subdue impossible color combinations.

Some people like to have their flowers in the front of the house where they can be seen. Others prefer to enjoy them in privacy. It is well to remember that in early spring and fall the weather may not be conducive to outdoor enjoyment. Plant so that cold weather bloom may be enjoyed from the warmth and comfort of the home, using the windows as a means of access to the garden. Flowers can also be planted so as to be seen from the patio or picnic area. In every instance, a garden with a pleasing pattern or design and an adequate background is more satisfying than one without.

The voice of experience is most helpful in planning a garden. Sources of help are garden clubs and friends and neighbors who may have had more garden experience. Much can be learned from visiting other gardens at home and on trips, nurseries, botanic gardens, arboretums and well-landscaped parks. All this will add to your knowledge of plants and how they grow.

In spite of the great variety of annual flowers listed in catalogs, relatively few are grown in gardens. This is unfortunate because they are a great source of summer and early fall color in the garden. Most of them are easy to grow from seed, and are not expensive when purchased as plants. They all bloom the first season or they could not be called annuals. A number will self-sow and come up year after year. No other type of flower gives so much bloom for so long a period during hot summer months.

Some annuals must be started early to bloom by early summer, such as vinca, verbena, hunnemannia, lobelia, scarlet sage. A few do not bloom until later in the summer no matter how early they are started, such as China aster and cosmos. A few will not bloom during very hot weather, notably calendula, stocks, salpiglossis, nemesia and nemophila.

Most annuals are free of common pes However, it will pay to plant only ru resistant snapdragons and wilt-resista asters. When a bed is used year af year, root rots may be prevalent as in cated by the plants wilting and dyi When this happens, try a new bed a avoid the other for annuals for seve years.

There is a tendency on the part many gardeners to set out annuals t early in the spring. Except for those th are called hardy, better wait until danger of frost is past. Even if there no frost, cold weather will stunt t seedlings.

Growing your own plants indoors us ally results in weak, spindly seedlin because of high temperatures and lack sunlight. Try growing them outdoors in coldframe. The plants will be sturdi and will transplant better.

Cleome, or spider flower, grows 3 to 4 feet high and has either pink or white flowers. Th annual is easily grown from seed, is valuable for mass planting in large borders

Roc

This effective group of annuals is pleasing because large masses of each kind are used

Genereux

One can fill borders with colorful, summer-flowering annuals at little expense

Petunias make good edging plants along walks, drives, are fine in window boxes too

Wherever new "foundation plantings" are of small shrubs, annuals make quick fillers

Roche

Roche

Annuals soften the hard lines of the brick curbing that edges the flower border

Annual Flowers for Special Uses

Annuals for Cut Flowers

Annual chrysanthemum	Larkspur	Salpiglossis
Ageratum	Lupine	Scabiosa
Browallia	Marigold	Snapdragon
Calendula	Matricaria	Stock
China aster	Mignonette	Sunflower
Cosmos	Nasturtium	Sweet pea
Calliopsis	Phlox	Sweet sultan
Gaillardia	Pinks	Thrift
Laceflower		Zinnia

Annuals to Dry for Winter Arrangements

Cockscomb	Globe amaranth	Honesty
Everlastings (*Acroclinium*, *Rhodanthe*)	Grasses	Strawflower
		Thrift

Annuals with Fragrant Flowers

Ageratum	Pansy	Sweet alyssum
Heliotrope	Phlox	Sweet peas
Mignonette	Pinks	Sweet sultan
Nasturtium	Scabiosa	Verbena
Nicotiana affinis	Stock	Virginian stock

Annuals for Partial Shade

Candytuft
Clarkia
Cornflower
Godetia
Larkspur
Lupine
Nicotiana
Pansy
Petunia
Tasselflower
Sweet alyssum
Verbena

Low-Growing Annuals

Ageratum, dwarf
Calliopsis, dwarf
Candytuft
Flax
Gypsophila
Lobelia
Marigold, dwarf
Nasturtium
Pansy
Petunia
Phlox
Portulaca
Sanvitalia
Snapdragon, dwarf
Sweet alyssum
Verbena
Zinnia, dwarf

Annuals Difficult to Transplant—Best Sown Where They Are to Bloom

California poppy
Evening primrose
Godetia
Gypsophila
Laceflower
Larkspur
Love-in-a-mist
Lupine
Mignonette
Nasturtium
Poppy
Portulaca
Scarlet runner bean
Sweet pea
Tree-mallow (*Lavatera*)
Virginian stock

Annuals Blooming After First Frost

Calendula
Petunia
Salvia
Stock
Sweet alyssum

Annual Vines for Shade and Privacy

Cardinal-climber
Cypress-vine
Gourds
Hyacinth bean
Moonflower
Morning-glory (Heavenly Blue, Pearly Gates)
Scarlet runner bean (edible)

Annuals With Long Season of Bloom

Ageratum
Browallia
Calendula (if summer is cool)
Gaillardia
Marigold
Nicotiana
Petunia
Pinks
Snapdragon
Spiderflower
Sweet alyssum
Thrift
Verbena
Vinca
Zinnia

May Be Fall-sown or They May Self-sow

Ageratum
Amaranthus
Balsam
Browallia
Calendula
California poppy
Calliopsis
Cornflower
Cosmos
Four-o'clock
Larkspur
Morning-glory
Nicotiana
Nigella
Perilla
Petunia, small-flowered
Poppy
Portulaca
Pricklepoppy (*Bartonia*)
Salvia farinacea
Snapdragon
Snow-on-the-mountain
Spiderflower
Summer-cypress
Sunflower
Sweet alyssum
Wild cucumber

Waterlily tulip blooms in early spring

Lilium formosanum is summer-floweri

WAYS TO USE BULBS

MOST flowering bulbs are perennials that come up year after year. A few, not being hardy, must be taken up and stored away from the cold over winter. Some of these tender bulbs are most desirable for summer bloom. They give effects not obtainable from other plants.

The bulk of the spring-flowering hardy bulbs must be fall-planted before the ground freezes. A few of the smaller ones, such as winter aconite, anemone, and some squills, should be planted as early as possible before they dry out and become worthless—by late September or early October. Lilies dry out easily, too, and should be planted as soon as they are received.

Although planting depths are given for all kinds of bulbs, it is more important to have good top soil beneath the bulb where the roots grow than to set the bulb at exactly the correct depth.

Places where bulbs may be used in t average garden are limitless. Some kin such as crocus and scillas, may be tuck in any place where they can grow and w not interfere with mowing. Others, li daffodils, can be put under ground cove such as periwinkle, around the bases trees, and in front of and in betwe shrubs and evergreens. Most bulbs a suited to planting all through any and flower beds and borders. The little bul are fine in the wild garden, around a po and in the rock or wall garden. Bul will even bloom in planter boxes.

Once planted, leave the bulbs alone they continue to bloom regularly. Th will vary with the place and the kind bulb, from several years to as many ten or more. Daffodils can keep it up f a quarter of a century at least.

Bulb foliage is sometimes unattracti after bloom. Tulips can be cut back

McFarland

Golden-yellow crocus clustered beneath the branches of evergreens make a pretty picture

Showiest of all tulips are the late double varieties, such as white Mt. Tacoma

Gottscho-Schleisner

Genereux

Clusters of spring-flowering bulbs are interplanted here between hardy perennials

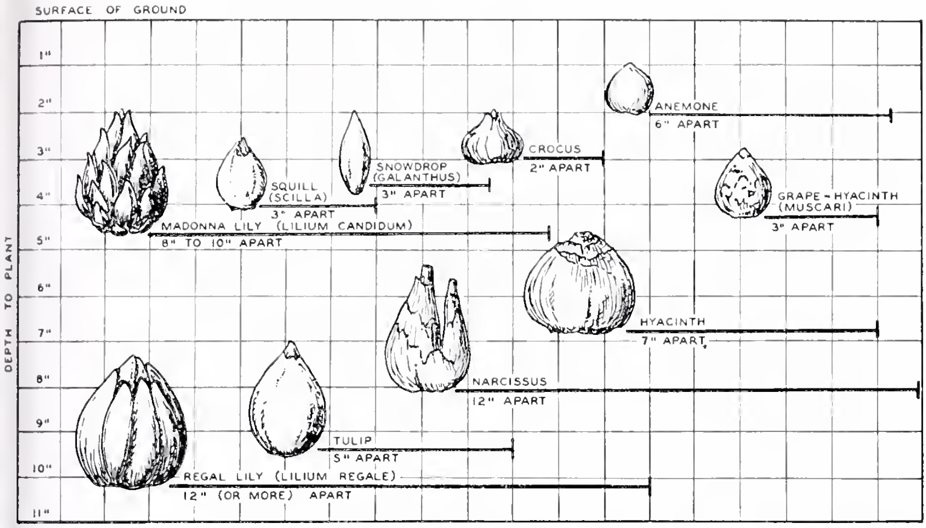
them in to mature and cure in some other bed. This is a lot of work and may harm the bulbs if not carefully done.

It is amazing how long a period of bloom is possible from spring-flowering bulbs if they are selected with this in mind. For instance, daffodils can be in bloom for five to six weeks by the use of early, midseason and late varieties. Tulips, by the use of species, double and single early, May-flowering and double late varieties, give us as much as two months of bloom. Starting with winter aconites and snowdrops, using all the other spring bulbs, then including a collection of lilies, one can have bloom until September. Using gladiolus planted every two weeks from March to early July, tuberous begonias, dahlias, hardy amaryllis and tigridia, there would be bloom from this

the bottom three leaves, and daffodils can be cut back half way without apparently affecting the next year's bloom. In small plantings, some prefer to braid daffodil foliage or tie it in a knot, to make it less floppy, so that other flowers can be planted in between. Still others dig their tulips after blooming and heel

The largest size crocus bulbs are the best buy because each bulb produces a large cluster of flowers the first year

Watson from Monkmeyer



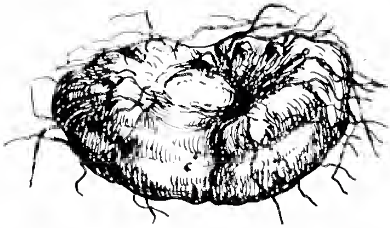
This chart shows how deep, and how far apart, various kinds of bulbs should be planted

group alone from early July to frost. It is all in the planning, always keeping in mind the goal of succession of bloom.

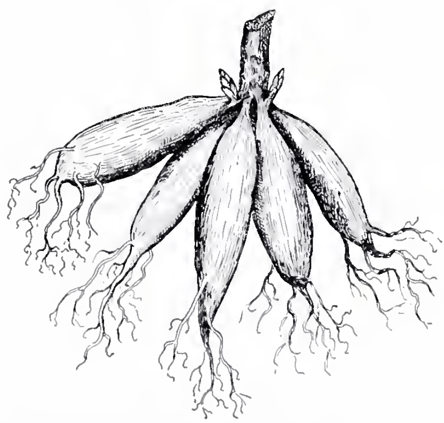
Contrary to many of the recommendations commonly given, bulbs may be fertilized with commercial fertilizers just the same as everything else in the garden. It is not necessary to use bonemeal.

With but few exceptions, such as dahlias and gladiolus, most bulbs may be planted in shaded areas and still flower, although the competition of tree roots will retard their growth slightly. A few, such as tuberous begonias, fancy leaf caladiums and achimenes, must have some protection from the hot summer sun in most climates.

Moles are often accused of eating bulbs, but they are carnivorous, not vegetarians. It is mice that use the mole burrows that eat bulbs. Mouse traps baited with peanut butter are a sure cure. Chipmunks are a pest, for they eat and carry away many small bulbs such as crocus, as will be discovered when these bulbs come up in the lawn or other beds where chipmunks have buried them. For control, try rat poison on peanut butter, put in their burrows or under a few slabs of wood where the birds cannot get at it.



Plant begonia tubers with concave side up



New growth starts where dahlia roots join stem. When dividing clumps, a piece of stem must go with each root

COMBINING BULBS WITH PERENNIALS FOR SUCCESSION OF BLOOM

Many gardeners strive to have a garden that is bright with flowers from spring to fall, but very few ever succeed in making such a garden. Part of the reason for this is lack of space to grow enough plants to put on a real show. More often, not enough thought has gone into selecting plants which will provide an uninterrupted flow of bloom.

In many instances, one could use no more than seven or eight basic kinds of hardy flowers, such as daffodils, tulips, iris, peonies, phlox, daylilies, hardy asters and chrysanthemums, and then, by selecting varieties within each group which flower at different times, have seven months of bloom from them alone. Bulb and nursery catalogues generally give the season of bloom of each variety or type of flower.

As a basic guide, the following list is offered. Included are hardy and tender bulbs, perennials, annuals and even a few native plants suitable for growing in gardens.

First Flowers of Spring

Crocus, especially *C. susianus, tomasinianus, sieberi*
Daffodils, as February Gold
Lenten-rose
Snowdrop
Winter aconite

Early Spring

Crocus
Daffodils (mid-season)
Grape hyacinths
Glory-of-the-snow
Hardy candytuft
Hyacinth
Lungwort
Pasque-flower
Primrose
Rockcress, both Arabis and Aubrieta
Tulips (early, double early and Kaufmanniana hybrids)

Late Spring

Bleeding-heart
Columbine
Daffodils (late varieties)
Daylilies, lemon, Dr. Regel, *dumortieri, middendorfi*
Iris
Japanese primrose
Leopardbane
Meadow-rue
Squills
Sweet rocket
Painted daisy
Peony
Tulip (May-flowering, double late)

Early Summer

Anchusa
Balloon-flower
Coreopsis
Daylilies
Delphinium
Foxglove
Gaillardia
Gas-plant
Hollyhock
Lilies, Olympic and Mid-century hybrids; Madonna
Peachleaf bellflower
Shasta daisy

Mid-Summer

Butterfly-weed
Cardinal-flower
Daylilies
Evening primrose
Flowering spurge
Lilies (Hanson, Aurelian and Preston hybrids, Gold banded)
Phlox, Miss Lingard
Stokes aster
Most annuals, as marigolds, zinnias, petunias

Late Summer

Cardinal-flower	Joe-pye-weed	Showy stonecrop
Chrysanthemums (early varieties and cushions)	Lilies (Henry, *speciosum*, *formosanum*)	Stokes aster
False dragonhead, Vivid	Pink turtlehead	Annuals, including asters, cosmos, castor bean, hunnemannia
Dwarf bleeding-heart	Plaintain-lilies	

Early Autumn

Chrysanthemum	Japanese anemone	*Salvia azurea*
Closed gentian	Lily, *formosanum*	Most annuals until frost
Hardy asters	Plumbago	Gladiolus, late June planted
Hardy begonia	Purple coneflower	Dahlias until frost

Late Autumn

Aster tataricus	Gaillardia	Annuals, as sweet alyssum, petunias, calendula, snapdragons
Coreopsis	Wilson monkshood	

Fall and Winter

Christmas-rose

USES OF SPECIAL-PURPOSE PLANTS

For Poorly Drained Locations

American bellflower	False dragonhead	Marsh marigold
Bergamot	Forget-me-not	Royal fern
Cardinal-flower	Globeflower	Sneezeweed
Cinnamon fern	Loosestrife (*Lythrum*)	Turtlehead

Good as Cut Flowers

Aster	Delphinium	Painted daisy
Babysbreath	False dragonhead	Shasta daisy
Chrysanthemum	Gaillardia	Stokes aster
Columbine	Iris	Sunflower
Coreopsis	Japanese anemone	Torch-lily
	Monkshood	

Plants That Endure Shade

Bergamot	Foxglove	Meadowrue
Bleeding-heart	Japanese anemone	Plaintain-lily
Christmas-rose	Lenten-rose	Purple coneflower
Columbine	Lily-of-the-valley	Virginia bluebell
	Lungwort	

Perennials Likely to Become Pests by Spreading

Buttercup	Lily-of-the-valley	Sunflowers (*Helianthus*)
Daylilies, *Hemerocallis fulva* and var. *Kwanso* from roadsides	Loosestrife (*Lysimachia*)	Giant knotweed (incorrectly called hardy bamboo)
Garden heliotrope (valerian)	Mistflower (hardy ageratum)	Some stonecrops
	Plume-poppy	

For Dry or Poor Soil

Aster	Daylily	Flowering spurge
Bouncing Bet (*Saponaria*)	False chamomile (*Anthemis*)	Gaillardia
Butterfly-weed		Thrift

Perennials With Fragrant Flowers

Grass pinks	Lemon daylily	Tufted pansy
Jupiters beard (*Centranthus*)	Lily-of-the-valley	Valerian
	Plantain-lily (*Hosta*)	

For Ground Covers and Grass Substitutes

Bugle (*Ajuga*)	Maiden pink	Periwinkle (*Vinca*)
English ivy	Moss pink	Serbian bellflower
Japanese spurge (*Pachysandra*)		Sweet woodruff

Foliage Other Than Green (may be gray)

Hosta sieboldi	Rue	Thyme
Lavender	Snow-in-summer	*Veronica incana*
Nepeta	*Stachys lanata*	Wormwood
Plume poppy		

SELECTING FLOWERS BY COLOR

For a White Garden (select white varieties)

Perennials		*Annuals*	
Bellflower	Iris	China asters	Pansy
Candytuft	Lilies	Cornflower	Petunia
Chrysanthemum	Phlox	Cosmos	Phlox
Columbine	Plaintain-lilies	Dahlias	Salvia
Coneflower	Shasta daisy	Geraniums	Snapdragons
Daffodils	Squills	Gladiolus	Verbena
Delphinium	Tulips	*Impatiens sultana*	Vinca
		Larkspur	Zinnia

Yellow Flowers

Perennials		*Annuals*	
Achillea	Globeflower	Calendula	Hollyhock
Alyssum	Goldenrod	California poppy	Hunnemannia
Buttercup	Iris	Calliopsis	Marigold
Chamomile	Helianthus	Cockscomb	Monkeyflower
Columbine	Heliopsis	Coneflower	Nasturtium
Coreopsis	Leopardbane	Gaillardia	Pansy
Daylilies	Sneezeweed		Pricklepoppy
Evening primrose	Stonecrop		

Blue or Purple Flowers

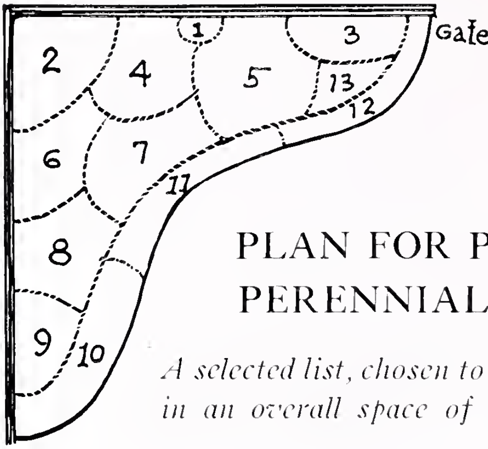
Perennials		*Annuals*	
Baptisia	Greek valerian	Ageratum	Cupflower
Bellflower	Iris	Anchusa	Forget-me-not
Bugloss	Mistflower	Browallia	Laceflower
Centaurea	Phlox	Candytuft	Lobelia
Delphinium	Plumbago	China aster	Pansy
Forget-me-not	Speedwell	Chinese forget-me-not	Petunia
		Cornflower	Salvia

Pink or Red Flowers

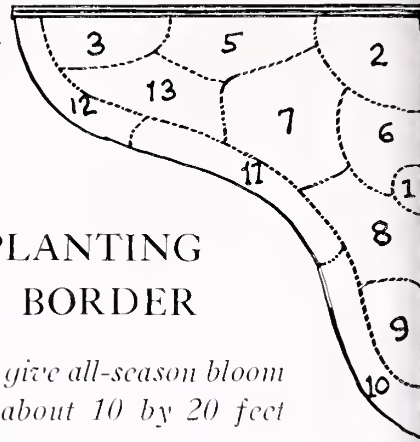
Perennials		*Annuals*	
Aster	Iris	Ageratum	Larkspur
Chrysanthemum	Jupiter's beard	Amaranthus	Periwinkle
Columbine	Lenten-rose	Balsam	Marigold
Coneflower	Maltese cross	Candytuft	Nasturtium
Coralbell	Pinks	China aster	Nicotiana
Daylilies	Primrose	Clarkia	Petunia
Delphinium	Sweet rocket	Cockscomb	Phlox
Foxglove	Torch-lily	Cornflower	Poppy
Hollyhock	Turtlehead	Cosmos	Salvia
		Flax	Sweet alyssum
		Four o'clock	Stock
		Godetia	Zinnia

Mixed perennial borders are always popular because they contain so many kinds of flowers. The beds in this garden are laid out in a quadrangular pattern

Gottscho-Schleisner



PLAN FOR PLANTING PERENNIAL BORDER



A selected list, chosen to give all-season bloom in an overall space of about 10 by 20 feet

Continuous Bloom, April to October

Plants listed approximately in the order of blooming.

Number on Plan	*Plant*	*Height in Feet*	*Color*	*Other Features*
11	**golden-tuft,** or **gold-dust** (*Alyssum saxatile*)	2/3 to 1	golden	soft yellow in var. *luteum*
2	**delphinium**	4 to 6	mostly blue	pink or white
6	**Siberian iris** (*Iris sibirica*)	1½ to 3½	lilac, wine, purple	sometimes white
10	**sweet William** (*Dianthus barbatus*)	1 to 2½	red-and-white, pink, purple, white	sometimes double
3	**daylily** (*Hemerocallis*)	1 to 4	yellow, red, pink, etc.	large flowers
1	**rose** Paul's Scarlet Climber	up to 12	scarlet	large flowers
9	**hardy phlox**	2 to 5	white, pink	blue, red
12	**dropwort** (*Filipendula hexapetala*)	2 to 3	white	has fern-like leaves
13	**Shasta daisy** (*Chrysanthemum maximum*)	1 to 3	white	large blooms
7	**mistflower** *Eupatorium coelestinum*)	1 to 3	blue	flowers like ageratum
4	**Japanese anemone** (*Anemone japonica*)	1 to 3	white, pink	flowers good for cutting
5	**hardy aster** variety (*Aster*)	1 to 5	white, red, blue, purple	crimson and autumn tints
8	**chrysanthemum**	1 to 4	white, red, pink	make fine clumps

A GUIDE TO CHOOSING HOME GARDEN FRUIT

MANY of us look forward to the time when we can grow our own fruit. If sufficient space is available and we are willing to give the trees and bushes the proper care, this is practical. But all too often they are not given the necessary pest control care and the fruit produced is diseased or wormy.

However, by growing our own it is possible to enjoy varieties which are of better quality than many that are grown commercially and none can compare in flavor with tree-ripened fruit.

Peaches are desirable because we may plant varieties not grown commercially, especially the white-fleshed kinds. White varieties, in order of season of ripening, are Erly-Red-Fre, Cumberland, Belle of Georgia. Yellows are Jerseyland, Redhaven, Golden Jubilee, Triogem, Fairhaven, Sunhigh, Halehaven, Redskin, After Glow, Lizzie.

Plums (tree-ripened fruit) are difficult to buy at stores. Those that will set fruit with their own pollen are Stanley, Shropshire damson, French damson. Those that must be pollinated by another variety are Bradshaw, Imperial Epineuse, Italian prune and Reine Claude. The Japanese varieties are more difficult to grow in many localities.

Sour cherries are easy to grow but sweet cherries need another tree to pollinate them. And with all cherries the birds are a problem if you have only a tree or two.

Apples and **pears** become large trees unless dwarfs are planted. Contrary to many advertisements, only apples and pears are available as satisfactory dwarf trees. Fireblight disease is a problem that as yet is difficult to control, particularly in pears. Better check with your agricultural experiment station to find out what varieties, if any, are practical for your locality—and for the space you wish to give them.

Strawberries are probably the most practical fruit for home gardens. As with all fruit, a sunny location is needed. And it must be very well drained. Since a bed goes down in yield after a couple of years, a new one should be started from runners the second season. June bearing varieties will yield better than everbearers, and many of them have better quality. The better June varieties are Armore, Fairland, Sparkle, Plentiful, Pocahontas, Catskill, Vermilion. For everbearers try Brilliant, Gem and Superfection.

Blueberries are worth trying if your soil is acid or if you can keep it acidified. The plants are decorative as shrubs and have lovely fall color. But the catalogs fail to say that every bird in the locality will stop by to eat the blueberries unless

Genereux

A corner of a fruit garden in which raspberries are trained to posts behind the blueberries, and strawberries are grown as "hills" (runners clipped off) to the right

How to Grow Strawberries

First Improve the Soil With Humus

A thick layer of compost, dug deeply into the bed before planting, will improve the fertility and drainage of the soil, making it ideal for strawberries

they are covered with netting. By planting early, midseason and late varieties, fruit will be abundant over a period of more than a month. The improved varieties include June, Stanley, Jersey, Earliblue, Bluecrop, Herbert, Dixi, Coville and Blueray. Try growing blueberries in the shrub border as you would azaleas.

Currants are practical if you like them. Usually only two or three bushes are needed. The same is true of gooseberries. The latter are very spiny. These fruits should not be grown within a quarter mile of white pines which are the alternate host of the blister rust disease.

Red raspberries are wonderful if only healthy stock is planted. Once a patch is started and the old wood cut out every year, it will last for years. Black raspberries take more room and, because of their tip layering, need more attention. Good red varieties are Taylor, Latham and Milton. Everbearing reds are Durham and September. Black varieties are Logan, Bristol, Cumberland.

Purple raspberries must be planted several hundred feet away from the red to prevent the spread of disease. Purple varieties are Sodus, Marion, Hedrick, Eldorado and Bailey.

Boysenberries, loganberries and similar types are not as hardy as other berries. They are long-caned and awkward plants, sometimes trained on a trellis the same as grapes.

Grapes are an old standby in home gardens. For ease of pruning it is much better to train them on a three-wire fence than on an arbor. Then instead of cutting every branch back to one or two buds each spring, all the new branches except one are cut off. Unless you prune grapes severely you will not get the yield you expect. Varieties in order of ripening are: Interlaken Seedless, Erie, Ontario, VanBuren, Captivator, Niagara, Fredonia, Brighton, Concord, Delaware, Seneca, Golden Muscat and Catawba. These will ripen from late August to mid-October.

The great problem with apples, plums, peaches, grapes and to a lesser extent other fruits is following an adequate dusting or spraying schedule. Most kinds need a minimum of three or four treatments, and more in the case of apples. The timing of sprays is most important. Since this varies from region to region it is well to ask your own agricultural experiment station for a spray schedule. Sometimes it is easier and quicker for the home gardener to dust rather than spray. It may not be quite as effective, but is much easier to do.

Setting Out the Plants

Rows are close spaced in this bed (12 inches apart) because runners will be kept cut off. Set plants with the crown at soil level

Remove the First Blossoms

Blossom clusters are removed the first spring so that all the strength goes toward developing strong plants which will bear heavily in the following spring

Gantner

The First Harvest

By keeping the strawberry bed mulched with straw, salt hay, or similar material, weeds are kept down, soil moisture is retained, and the fruit is clean

Watson from Monkmeyer

Gottscho-Schleisner

A scarecrow may not keep birds away, but it adds a touch of humor to the vegetable garden

How to get quality produce from the

HOME VEGETABLE GARDEN

THE prime object in growing your own vegetables is to have a continuing supply of fresh, succulent crops just when you want them, and to enjoy the kinds of vegetables having superior quality which may not be purchased locally.

To achieve this end, several points of culture are important. First of all, vegetables need full sun at least half the day, preferably all day. Better than average soil is necessary to produce certain vegetables, such as root crops and salad plants. An abundance of organic matter in the soil improves the quality of carrots, beets, radishes and other root crops. For this reason, the more rotted leaves, sawdust, manure or other organic matter mixed with the soil, the better. The soil is improved further by sowing winter rye in early September to dig under in the spring. Fertilizer, such as that used on the lawn, is needed at least once a month during the growing season.

Rainfall is seldom sufficient, so some provision should be made to irrigate. A hand-held hose is a waste of time when applying one inch of water a week—the average required amount. Use some type of a sprinkler, and set a tin can on the ground to measure the amount of water being applied.

Cultivation is only necessary to control weeds and keep the soil surface broken to take in rain. Other than this, cultivation is nothing more than exercise for the gardener. It does not conserve moisture, as old timers still believe. Very often mulching such crops as tomatoes improves growth, reduces labor, and keeps the fruit clean.

Always work out a plan on paper before sowing a single seed. Most folks

Singer

It's good to try different kinds of vegetables each year. Kohlrabi (*above left*) develops best when sown in early spring or after midsummer. Harvest while the skin is still tender. Cook the stem tubers like turnips

Top right. Savoy cabbage has better flavor and texture than other kinds. Heads can be gathered as soon as they are solid, but harvesting can last for many weeks from even one short row

Bottom right. Butternut squash is small sized, has thick meaty neck, small seed cavity. It's delicious when split open, baked with butter and seasoning. Squash is botanically a fruit, even though referred to as a vegetable

Gottscho-Schleisner

plant far more radishes, lettuce, beans and other vegetables than the whole neighborhood can use. It is better to make frequent plantings and only a little each time of vegetables that soon go past their best eating stage. Try sowing just a few feet of row of each one at a time. Try different varieties to add to the fun.

Some crops that should be sown at frequent intervals are corn, radishes, lettuce, beans, and peas. Plant extra rows of the vegetables being grown for quick freezing. Summer sowing for fall harvesting pays with endive, lettuce, cabbage, carrots, beets, radishes, spinach and others.

Always be ready to plant a new crop to replace the one harvested. In this way it is possible to get at least two and sometimes three crops from the same land. Some crops require the entire season to grow, such as parsnips, salsify, sweet potatoes, squash, melons, peppers, Brussels sprouts. Very often a row of radishes or Bibb lettuce may be grown in between the rows of the slower growing, long season crops. Through advance planning, we can get full value from a plot of land.

The varieties used are important because some have better eating qualities than others. For instance, why grow green beans with strings when the better varieties have none. The following varieties are recommended for home gardens by the Ohio State University Agricultural Extension Service.

Recommended Vegetable Varieties for Home Gardens

Note: Varieties marked with a (*) are suitable for freezing as well as for immediate use.

Asparagus—Mary Washington
Beans, bush, green—Stringless Black Valentine, Stringless Green Pod*, Tendergreen*, Contender, Top Crop
Beans, bush, wax—Surecrop*, Pencil Pod Black Wax*, Round Pod, Kidney Wax (Brittle Wax)*, Top Notch Golden Wax, Cherokee
Beans, pole, green—Kentucky Wonder, McCaslan, Blue Lake
Beans, pole, wax—Kentucky Wonder Wax
Beans, pole, lima—King of the Garden, Burpee's Best (Challenger)
Beans, bush, lima—Fordhook*, Baby Fordhook, Early Market, Green Seeded Fordhook 242*, Thorogreen (Cangreen, Allgreen), Triumph
Beans, green, shell—Horticultural
Beans, dry or navy—Michelite
Beets—Early Wonder, Detroit Dark Red*
Broccoli—Italian Green Sprouting (Calabrese)*, Waltham 29 (fall), DeCicco
Brussels Sprouts—Long Island Improved*
Chinese Cabbage—Chihili, Michili
Cabbage, early—Resistant Golden Acre, Marion Market, Bonanza, Globe Glory, Badger Market
Cabbage, late—Wisconsin All Season, Wisconsin Hollander 8, Mammoth Red Rock, Drumhead Savoy, Penn State Ballhead
Cauliflower—Early Snowball*, Snowdrift, Super Snowball
Carrots—Nantes (Touchon)*, Danvers Half Long, Chantenay*, Imperator, Gold Spike
Celery, early—Golden Self-Blanching, Cornell 619, Michigan Golden
Celery, green—Summer Pascal, Giant Pascal, Emerson Pascal, Utah 52-70
Chard, Swiss—Lucullus, Rhubarb
Collards—Cabbage, Vates (improved Georgia type)
Corn, sweet early—North Star, Marcross, Carmelcross, Barbecue, Hoosier Gold, Golden Beauty
Corn, sweet, midseason—Golden Cross Bantam*, Tenderfreezer*
Corn, sweet, late—Ioana, Aristogold Bantam, Tendermost*, Victory Golden*, Golden Hybrid 2057, Aristogold Bantam Evergreen, Iochief
Cucumber, early—Early Fortune, A & C, Burpee Hybrid, Straight Eight, Marketer
Cucumber, pickling—National Pickling, Ohio MR-17, Packer
Eggplant—Black Beauty, Burpee Hybrid, Black Magic Hybrid
Endive—Full Heart Batavian, Green Curled, Broad Leaved Batavian
Kale—Dwarf Blue Scotch, Dwarf Green Scotch Curled, Dwarf Siberian
Kohlrabi—Early White Vienna, Purple Vienna.
Lettuce, leaf—Salad Bowl, Grand Rapids, Black Seeded Simpson, Slobolt, Oak Leaf, Bronze Beauty, Bibb
Lettuce, head—Great Lakes, Imperial 44, Imperial 847, Pennlake, Cornell 456, Premier Great Lakes, Progress
Muskmelon (Cantaloupe)—Tip Top, Ohio Sugar, Pride of Wisconsin, Honey Rock, Schoon's Hardshell, Iroquois, Delicious 51
Mustard—Fordhook Fancy, Tendergreen
Okra—Dwarf Green Early, Perkins Spineless
Onion, seed—Ebenezer, Brigham, Yellow Globe, Sweet Spanish
Onion, plants—Sweet Spanish

Onion, sets—Ebenezer, White Portugal, Yellow Globe
Parsley—Moss Curled, Paramount
Parsnip—Hollow Crown, Model
Peas—Little Marvel, Premium Gem, Thomas Laxton*, Gradus*, Wando*, Freezonian*, Laxton's Progress*
Pepper, green—World Beater, California Wonder, Yolo Wonder, Burlington Wonder
Pepper, yellow—Oshkosh
Pepper, pimiento—Sunnybrook, Early Pimiento
Pepper, hot—Hungarian Wax, Long Red Cayenne, Chili
Popcorn—Purdue 31 (Yellow), Purdue 38, White Hulless
Potatoes—Irish Cobbler, Katahdin
Pumpkin—Small Sugar, Connecticut Field
Radish—Early Scarlet Globe, White Icicle, Cherry Belle, Cavalier
Rhubarb—McDonald*, Victoria*, Canada Red*
Rutabaga—American Purple Top (Long Island Improved)
Salsify—Sandwich Island
Spinach—Long Standing Bloomsdale*, Virginia Savoy, King of Denmark*, America
Squash, summer—White Bush Scallop, Summer Straightneck, Zucchini, Cocozelle, Caserta
Squash, fall—Table Queen, Butternut
Squash, winter—Delicious*, Golden Hubbard*, Green Hubbard*, Blue Hubbard*
Sweet Potato, dry flesh—Yellow Stem Jersey
Sweet Potato, moist flesh—Nancy Hall, Porto Rico, Gold Coin
Tomato, early—Pritchard, Valiant, Stokesdale, Queens, Early Red, Big Early (seed supply limited), Moxeton Hybrid (seed supply limited)
Tomato, late—Rutgers, Marglobe, Longred
Tomato, yellow—Golden Jubilee
Turnip—Purple Top White Globe
Turnip, greens—Shogoin
Watermelon—Kleckley's Sweet, Harris Earliest, Early Kansas, Hawkesbury, New Hampshire Midget (icebox type)

How to Train Green Peas

Chicken wire supported by strong stakes is ideal support for peas. Stretch a string along the outside of row when plants are small to start them climbing

Singer

1. Radishes, followed by bush lima beans—succession cropping.
2. New Zealand spinach—all the season.
3. Spinach, followed by peppers and eggplant—succession cropping.
4. Spinach, companion crop with tomatoes, peppers, and eggplants.
5. Onion sets, followed by tomatoes—companion cropping.
6. Lettuce, companion crop with tomatoes and with broccoli in row 7.

Rows 18 inches apart.

VEGETABLE GARDEN PLAN

A 20- by 40-foot plot, planned for companion cropping and succession cropping, to get the maximum harvest from a small area

The rest of the rows, not shown in the photograph above, were planted thus:

7. Broccoli—all the season.
8. Peas, dwarf, early.
9. Cabbage, late.
10. Peas, dwarf, midseason.
11. Celery, all the season.
12. Cabbage, early, followed by beets.
13. Kohlrabi, followed by carrots.
14. Onion sets, followed by carrots.

15 and 16. Onions from seeds, all season.
17 and 18. Beets, followed by bush beans.
19. Swiss chard and salsify, each half of the row, all the season.
20 and 21. Bush beans, followed by beets.
22 and 23. Carrots, followed by spinach.
24 and 25. Parsnips, half of each row, all the season. The other half of the two rows occupied by three rhubarb plants (3 feet apart)—perennial.

This is a plan that has proved successful; but certain substitutions may be made, to suit individual tastes. Radishes, spinach, lettuce, and onion sets, all very short-season crops, are interchangeable in succession and companion cropping. Whenever possible, root crops are followed by top crops in succession cropping, and top crops by root crops. More tomatoes may be planted instead of eggplant and peppers—and so on.

Important Pests on Vegetables, and Their Control

Aphids, on cabbage, melons, tomatoes, broccoli: nicotine spray or malathion dust.

Cabbage worms, on cabbage, broccoli: rotenone spray or dust.

Cutworms, on tomato seedlings: paper collars around stems, extending 2 inches below soil surface.

Flea beetles, on cabbage, peppers, tomatoes: rotenone spray or dust. DDT.

Maggots, on cabbage, onions: treat soil or plants with chlordane; or tar paper collar on cabbage seedling.

Mexican bean beetles, on beans: rotenone spray or dust, or methoxychlor, on both sides of leaves.

Squash borers, on squash: slit stem, kill borers, mound soil over wound.

Singer

When in full bloom, nothing is quite so impressive as a broad border of iris combined with perennials which flower at the same time

GARDEN IRIS

Clara May Frederick

EVERY gardener has definite likes and dislikes which are taken into consideration when planning the garden. Regardless of this, the first thing to decide, when selecting iris, is the way they are to be used. In other words, are they intended for exhibition, landscaping effect, color at a particular time, or perhaps to create a special garden picture?

Iris of all kinds are most effective when grown in clumps. Usually it takes at least three roots or rhizomes to make an effective clump. Spaced a foot apart, they will make a colorful clump the first year, or by spacing them 2 feet apart, an effective clump will result by the second year after planting.

When many varieties are needed to fill a given space, the cost of obtaining enough plants to make an immediate show might be prohibitive. In this case, choose the better kinds, plant them for whatever color you can get at first, and by the third year the clumps will be ready for dividing and replanting. Then, there will be enough divisions from each original plant to make a big clump of each one.

Most iris troubles are the result of improper culture. First of all, iris needs good drainage, and even though a few types, such as the Japanese, can be grown near water, they should still be planted on elevated soil well above the water line. Tall bearded iris, particularly, rot in perpetually moist soil.

Iris require full sunlight, too, to make the best growth, sturdy stalks, and disease-free rhizomes. Crowding other plants around the base of iris encourages diseases and iris borer.

Overfeeding produces soft growth which is very susceptible to root rots. It is safer

Roche

McFarland

1. *Above left.* Dwarf iris are the earliest

2. *Above right.* Intermediate type comes next.

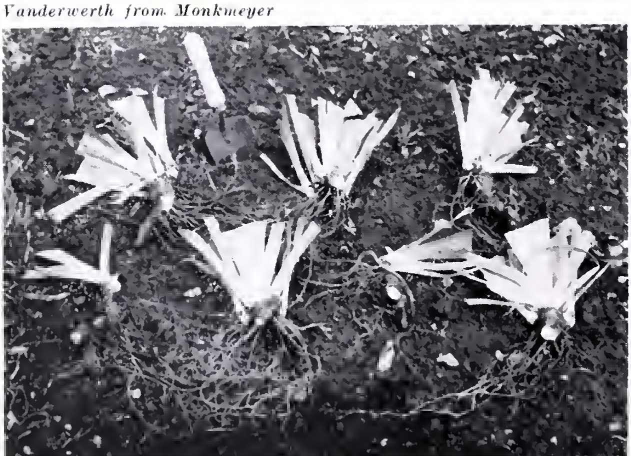
Vanderwerth from Monkmeyer

CONTINUOUS BLOOM

to add humus and plant food to the soil before planting, which is done usually from July to September. Then only light feeding early each succeeding spring is necessary.

The spring clean-up of last year's old foliage will go a long way toward controlling diseases and pests. Since this refuse carries disease spores and insect eggs, burn it or otherwise remove it from the garden.

Iris borer spray, containing DDT, is



How to Divide Iris

Above. Dig an old clump, when it is through blooming, and wash all soil from all of the roots

Left. Cut off strong new rhizomes, remove dead leaves, and replant divisions in groups, spacing them 10 inches apart

Roche

McFarland

FROM IRIS

3. *Above left.* Truly Yours, a tall bearded kind

4. *Above right.* Siberians follow bearded iris

available from garden stores or at least from specialty iris growers. However, any garden spray containing DDT and also a fungicide, such as ferbam or captan, could be used for both pests and diseases. However, other than controlling borers with DDT, which should be applied at weekly intervals from the time growth starts in spring to flowering, taking preventive measures by giving the plants good growing conditions is more effective than treatments. At any rate, if plants do become infected, dig out diseased roots, cut away spotted leaves and if the plants still are not healthy, move them to a better location.

5. Spuria varieties make excellent clumps, are good cut flowers, and extend the season

6. Japanese varieties are the last to bloom. They do well in an average garden soil

Genereux

Corliss

Gottscho-Schleisner

Iris cristata makes low, spreading clumps of lovely lavender flowers in spring

Guide to Better Iris

The following lists of iris may help in choosing just the variety to fulfill a particular need. All the varieties listed are moderately priced, the majority being available from growers for less than $3.00.

Dwarf Iris

Dwarf iris are between 4 and 15 inches tall and bloom about a month before the tall bearded kinds. After they become established, they often are a mound of color, with flowers completely hiding the foliage. A selection of good varieties follows:

Ablaze, yellow standards, red falls
Atroviolacea, 6 in., red-violet
Beauty Spot, plum-purple
Bright Spot, white, red-violet blaze on fall
Cherry Spot, 7 in., white reddish falls, white beard
Dreamchild, light lavender blend
Fairy Flax, 11 in., clear, true blue, white beard
First Call, 10 in., pale cream and lilac
Inchalong, 4 in., pale lemon-yellow
Keepsake, 12 in., clean, bright yellow
Little Elsa, 10 in., lemon-yellow
Mist-O-Pink, 8 in., grayish rosy shade
Sky Patch, 4 in., blue
Stint, 4 in., very dark purple, blue beard
Tampa, 14 in., red-violet
The Bride, 6 in., white

Intermediate Iris

Intermediates bloom after the dwarfs and before the talls, with blooms nearly as large as the talls. They range in height from 15 to 24 inches. The following varieties may bloom in the fall as well as in the spring.

Autumn King, blue-purple
Autumn Haze, soft lavender
Autumn Queen, white
Bountiful Blue
Eleanor Roosevelt, true purple
Gibson Girl, really a re-blooming tall bearded variety, light yellow with plicata stitching of red-violet
Golden Cataract, good yellow

Table Iris

Table iris are excellent cut flowers (hence the name) growing on fairly tall, willowy stems. The flowers are small and more delicate than the tall bearded, although they have the same form and bloom at the same time as the talls.

Chewink, 24 in., light blue, yellow beard
Daystar, white, with bright orange beard
Gay Hussar, 28 in., lemon and oxblood-red
Pewee, 18 in., pure cool white
Siskin, 22 in., yellow
Two for Tea, orchid pink

Siberian Iris

Siberian iris bloom after tall bearded, lengthening the season. They are excellent for arrangements, being very similar to the florist's iris in form. They are very reliable bloomers, making large clumps, but do not need dividing as often as many other types.

Caesar's Brother, 30 in., dark blue-violet
Eric the Red, wine-red
Perry's Blue, 40 in., sky-blue
Snowcrest, 35 in., white, yellow beard
Tycoon, the largest of the Siberians, dark purple

Spuria Iris

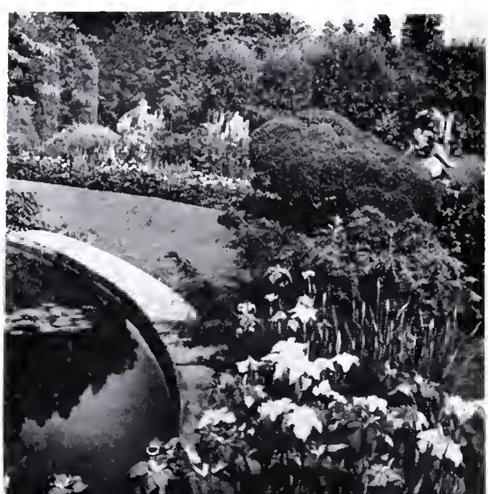
The spurias are not as well known as they deserve to be, since they are perfectly hardy and do provide iris blooms long after all the spring blooming ones are gone. In addition, spurias are the tallest of our garden iris and the foliage is excellent for background planting in flower borders, remaining clean and healthy throughout the summer.

Dutch Defiance, blue with a yellow blaze on the falls
Larksong, creamy white and yellow
Monspur Blue, yellow blaze on medium blue flower
Mount Wilson, blue
Ochroleuca gigantea, white with yellow
Russet Flame, outstanding bronze
Shelford Giant, 4¼ ft., creamy white, yellow area on falls
Sunny Day, tall yellow
Two Opals, cream and lavender
Wadi Zem Zem, large creamy yellow, one of the best

Japanese Iris

Many Japanese iris are sold as seedlings and are listed as a strain, such as: Marhigo series; Pinafore series; Rhinegold series; Rigoletto series. However, the following are some recommended named varieties:

Blue Giant
Delft Blue
Fascination
Gold Bound
Great White Heron
Hayden
La Favorite
Light at Dawn
Purple and Gold
Sea Titan
Storm at Sea



Japanese iris have elegant flowers and rich coloring unmatched by other kinds

Gottscho-Schleisner

Cassebeer

A fine, well-branched stalk of the ruffled, white, tall bearded iris Snow Flurry

Tall Bearded Iris

Cool Whites

Cliffs of Dover, ruffled, flaring form
Helen McKenzie, not as large as some, but weatherproof
Snow Flurry, early blue-white
Tranquility, rounded form
Wedding Bouquet, broad, flaring falls

Warm Whites

New Snow, tall, yellow beard
White Tower, massive sculptured blooms

Cream, or Light Yellows

Amandine, lemon-cream
Desert Song, ruffled, heavy substance
Pinnacle, white standards, yellow falls
Song of Songs, lace-edged, gold-banded white
Summit, deeper color contrast than Pinnacle
Truly Yours, tall, big flowers, very late

Yellows

Limelight, canary to greenish lemon; lacy, serrated edges
Ola Kala, good exhibition flower, Dykes medal, 1948
Temple Bells, apricot-yellow, brilliant orange beard

Browns

(tan, copper, and bronze)

Argus Pheasant, Dykes Medal, 1952
Golden Russet, large flowers
Inca Chief, glowing bronzy brown
Summer Song, orange-buff, weather resistant

Red or Red Effect

Garden Glory, maroon
Oriental Glory, red-rose, purple blaze on falls
Technicolor, bright reddish brown
Solid Mahogany, early, medium height
Worthington, rosy red, great garden value

Salmon or Apricot-Pink

Ballerina, fine form
Cloudcap, the biggest pink
Happy Birthday, bold foliage, strong stems
Apricot Glory, medium height, strong color
Palomino, white fall has brilliant orange beard

Orchid or Rose-Pink

Crispette, lacy petals
Dreamcastle, dark orchid-pink
Chantilly, almost a blend, serrated petals
Mary Randall, Dykes Medal, 1954
Pink Plume, bright orchid-pink
Radiation, raspberry-pink

Blends

Lady Mohr, oyster-white, greenish yellow, all with a purplish cast
Morning Bright, cream and rose, late flowering
Cascade Splendor, light tan blend
Tranquil Moon, yellow standards, white falls

Light Blues

Bluebird Blue, beautiful clear color
Great Lakes, good exhibition variety, tall
Jane Phillips, early flowering medium height

Lady Ilse, celestial blue
Ponder, medium height, good grower
Sky Above, excellent form, white beard, slender stalks

Medium to Dark Blues

Blue Rhythm, good exhibition stem, tall
Blue Sapphire, extra large flowers and sturdy stems, Dykes Medal, 1958
Columbia, medium dark blue
Gulf Stream, early dark blue
Seafarer, medium, rich blue

Blacks

(dark red-violet and blue-black)
Black Forest, short, small flowers, early
Black Hills, blue-black, beard to match
Black Orchid, large flower, early
Indiana Night, late flowering
Sable, early, reliable

Oranges

Orange Banner, very large, medium height
Orangeman, tall
Top Flight, apricot-orange, rich beard
Zantha, light orange, huge flowers

Violet or Purple

Elmohr, very large, mulberry purple, heavily veined
Violet Harmony, Dykes Medal, 1957, good exhibition variety, long in bloom
Master Charles, brown shading on haft

Plicatas

(Stitching of contrasting color around the petals)
Blue Shimmer, good exhibition flower, large, well-branched, white with blue
Caroline Jane, good form, white and blue
Firecracker, yellow and red
Masked Ball, true plicata, but standards are almost solid dark blue, falls stitched with blue
Raspberry Ribbon, white with rosy-violet
Bazaar, rose with brown

Bicolors

(Including Amoenas, Neglectas and Variegatas)
Gaylord, white standards, blue falls, orange beard
Helen Collingwood, white with purple falls
Lothario, light and dark blue-violet
Staten Island, yellow standards, red falls
Wabash, white with blue, medium sized flowers

Iris in the garden of David Hall, famous originator of some of the finest varieties available today, including the "flamingo pinks"

Corliss

White Knight is one of the strongest growing, best formed of present white hybrid teas

The color of hybrid tea Kordes Perfecta is unique—cream-white flushed with carmine

ROSES COMPLETE THE LANDSCAPE

Frank H. Abrahamson

FEW roses require pampering to produce a splendid show of blooms. But, to insure maximum performance, be prepared to maintain a regular schedule of watering, feeding, and dusting or spraying, to keep the plants growing vigorously and free of diseases and pests.

There are several classes of roses, all useful, that will grow well wherever the soil is well drained, and where they can get at least four hours of sunlight a day (preferably in the morning). They must be out of range of competing roots from near-by shrubs and trees.

Here are typical ways to utilize roses. Species and shrub types are ideal for filling gaps in the shrub border. As ground covers, use ramblers or creeping varieties such as Little Compton Creeper, Wichuraiana and Max Graf. Cover walls, fences, lattice or arches with repeat-blooming climbers. In the rock garden, use the charming miniatures which are currently coming into high favor, both for the garden and as winter house plants. Low-growing floribundas quickly develop into compact, ever-blooming plants suitable to plant in borders or as a low hedge. Hybrid teas and grandifloras are striking either as specimen plants among annuals and perennials, or set in beds by themselves. For a formal effect, or to enjoy something unusual, plant one or more hybrid teas which have been grafted onto a sturdy understock to produce a tree rose.*

The final choice of varieties, of course, will be governed by your preferences for fragrance, color and the use of the flowers

*For a more complete discussion of rose varieties, rose types, and how to use them, refer to the HANDBOOK ON ROSES, published by the Brooklyn Botanic Garden.

Transplant an old hybrid tea when it is dormant, in early spring preferably. Set plant in hole large enough to spread roots

Refill with good top soil, pressing soil in between the roots as each shovelful is added, until hole is nearly level full

How to Transplant a Rose Bush

Then, firm soil around the roots, so that the plant is well anchored. Fill the hole with water to settle soil between the roots

After the water has drained away, hill soil around the stems, as pictured, and prune back top by at least half its height

McFarland

Gottscho-Schleisner

How to Put Climbing Roses to Good Use

A light tracery of clim ing roses over a sp wood fence makes a fi background for a rose b

—for landscape effect, exhibit in shows, color in the garden, to arrange in the house, or to make into corsages.

To begin with, however, consider these time-tested, universally-acclaimed varieties:

Hybrid Teas—*Chrysler Imperial* (red), *White Knight, Burnaby* (yellow), *Peace* (yellow and pink blend) and *Pink Favorite*

Floribundas — *Spartan* (red), *White Bouquet, Goldilocks* (yellow), *Betty Prior* (pink) and *Fashion* (pink blend)

Grandifloras—*Carrousel* (red), *June Bride* (white), *Buccaneer* (yellow), *Queen Elizabeth* (pink)

Climbers—*Blaze* (red), *City of York* (white), *Paul's Lemon Pillar, New Dawn* (pink) and *Mrs. Whitman Cross* (orange blend).

Roses may be planted at almost any time except in winter. Bare-root plants

Drape walls with climbers spaced far enough apart to expose some wall surface

O. M. Scott & Sons

Boundary post-and-rail fences are an ideal place for a display of climbing roses

F. S. Lincoln

are generally "in season" from November until April. You can get them locally or from mail order nurseries. Most of the latter send colorful catalogs on request once or twice a year. If you do not see their advertising, ask the American Rose Society* to send you a list.

If the growing season has begun before you think about buying your rose plants, it is best to get potted plants from a local nurseryman where one may select them while they are growing and blooming.

Planting Methods

The actual planting operation is much like that for any other deciduous shrub. Put bare-root plants in water as soon as they are obtained, and plant them within the next 24 hours if possible. Dig a hole deep and wide enough to hold the roots without bending them upwards. Mix a cup of superphosphate and a shovelful of organic matter (peatmoss, compost or well-rotted cow manure, etc.) deeply into the soil in the bottom of the hole. Make a mound of top soil in the center of the hole and fit the bare-root crown on it until the bud union (the knob where the main stem and branches join) is about at ground level; spread the roots down the side of the mound. Cover the roots with top soil. Tramp the soil firmly around the roots and fill the rest of the hole with water to work out any air pockets that may be left. After the water settles, fill the rest of the hole with soil and build a mound about 8 inches high around the stems. After the leaf buds begin to sprout, remove this protective mound.

Next, put a 3-inch-deep mulch of peat moss, ground corn cobs, buckwheat hulls, sawdust or another similar material over the top of the beds to help conserve water, keep the ground cool, cut weed growth and to some extent prevent diseases from spreading by keeping water from splashing. Sprinkle fertilizer containing nitrogen on top of this layer, to help it decay and to counteract loss of plant food taken from the soil by decaying mulch.

Start regular spraying or dusting (either method is effective) as soon as growth begins. A mixture (which you can buy) containing Captan (for blackspot), Karathane (for mildew), Aramite (for mites) and Malathion (for insects) has worked well in recent years. New chemicals constantly appear on the market, however, and your garden store may carry a better combination suited to your particular area. Apply it faithfully once a week, regardless of whether or not there are signs of damage. When some diseases appear, often it is too late to cure them. If you prefer to dust, do it in the evening when dew will help it stick better. If you spray, get out early in the morning so that the sun will dry it as soon as possible. Cover both the upper and lower leaf surfaces thoroughly. Remove and destroy any spotted leaves as soon as they appear.

Watering and Feeding

To water roses properly, attach a soil-soaking device to the garden hose and give the beds about an inch of water. Do not use sprinklers which will wash off protective dusts or sprays and spread disease in splashing water drops. Repeat this operation once a week during the growing season.

Give each newly-planted rose a light feeding (about one handful) of a well-balanced fertilizer (like a 5-10-5) after the first blooming period is over. Start feeding established bushes (in the garden one year or more) earlier — as soon as spring pruning is finished and before they start to grow. Give three feedings during spring and summer, unless you are using the newly-introduced ureaform fertilizers which need to be applied only once each year (in the spring) to supply all the nitrogen that a plant needs for the entire season.

Cut off faded blooms just above the top five-leaflet leaf on the stem. You can cut longer-stemmed flowers for in-

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*American Rose Society, 4048 Roselea Place, Columbus 14, Ohio.

Dusting. Direct rose dust (and spray too) up under leaves so that both leaf surfaces get covered. Dust when air is still, as in the evening. Apply pesticide every ten days or so

McFarland

Feeding. Hybrid teas, floribundas and everblooming climbers can be fed three times a year—early spring, as they first flower, and in late summer. Use a rose fertilizer

TIPS ON ROSE CARE

door use from established plants, but always leave at least two five-leaflet leaves since new shoots will develop from the buds at their base.

After the second killing frost forecasts the approach of winter, strip any remaining leaves from each plant and destroy them. Cut back tall canes enough to keep them from whipping in the wind and loosening the roots. Then tie the canes together. If the ground freezes solid in your area, bring in enough soil from another part of the garden to hill up an 8-inch mound around the base of each bush. After the first of the year, lay old Christmas tree branches on top of the beds. This will keep the ground frozen during any winter thaws, and prevent heaving which could injure roots.

As soon as the danger of killing frosts is past and buds begin to swell, limber up your pruning shears and remove all dead, diseased and weak stems. Cut back until you find white wood clear to the pith of each cane. Remove all wood one-quarter inch above an out-facing bud to produce an upright bush, or above an in-facing bud to induce a sprawling variety to make a compact plant. Paint all cut surfaces with orange shellac, or cover them with tree paints to keep boring insects out.

There is no substitute for a regular spraying or dusting, watering and fertilizing program, if you want to succeed with roses. Other plants will prosper under the same care, too.

Roche

Singer

Watering Method

Above left

It is best to put water on the soil rather than using a sprinkler. The "water wand" is easy to use and does not wash soil away

Summer Mulch

Above right

After spring growth has started and plants have been fed, mulch with buckwheat hulls or similar material to control weeds

Tieing Tree Roses

Middle right

Trunks of tree roses should be tied in at least two places to strong stake. Use soft cord to prevent injury to the bark

Puddling the Roots

Bottom right

When setting out a new plant, stir rose roots into a bucket of thick muddy water. This coats the roots with mud, as illustrated, which hastens new root formation

Vanderwerth from Monkmeyer

GROWING GLADIOLUS

Clara May Frederick

TO most gardeners, gladiolus are grown for cutting and summer color in the garden. Color selection is endless, and choice of varieties is based often on personal likes in this respect.

There are several devices that anyone can use to extend the period of bloom from gladiolus, and so have a colorful garden all summer. One way is to select varieties that bloom at different times. The better catalogues indicate the season in two different ways. One is to list the number of days, on the average, it takes a variety to bloom after planting. The other is to designate the flowering season, from "early" to "late." In general, the small-flowered types bloom earlier than the large-flowered.

Another scheme is to plant both smaller and larger sized corms at the same time. The large ones bloom ahead of the smaller ones. Many gladiolus growers sell different sized corms of a variety, and any corm measuring about three-quarters of an inch or more across will bloom easily.

Still another plan is to make several plantings two weeks apart, of a variety, beginning as soon as the weather is settled in spring.

Gladiolus do not require special soil to flower well. Heavy clay soil is the least desirable; at the other extreme, sandy soil to which humus has been added gives excellent results.

The site should be sunny and protected from strong winds. Gladiolus may be planted in rows for cutting or planted in groups among low-growing annuals and perennials.

Grown in rows, make a trench or trough with a hoe or shovel, about 5 inches deep. Sprinkle only enough garden fertilizer along the bottom to barely whiten the soil. Mix this into the bottom soil before placing the corms about 6 inches apart. Cover with 5 inches of soil. Label the row with the variety name. Light feeding may be done when the plants are half-grown, but regular watering, and mulching to control weeds, are of greater aid to getting good bloom.

Both small- and large-flowered types are effective when planted in groups in the garden. The heaviest flowered stalks may need support to keep them straight and erect; the small ones rarely need staking.

Thrips is the principle pest, and to control it, begin spraying with a DDT mixture when the plants are a foot or so high, and continue every week or so until the buds are fully formed. Any plants which develop stunted or yellow leaves, and do not bloom, are diseased and should

Gladiolus grown for cutting are best planted in rows 2½ feet apart. When cutting stalks, let the bottom leaves stay on plant

Roche

be pulled up and destroyed to keep the disease from spreading.

Classification Method

The catalogues of firms that specialize in gladiolus bulbs can be confusing to anyone who is not familiar with the methods used to list and describe varieties. However, once the system is understood, then the catalogues become a source of considerable useful information.

To assist gardeners in knowing the size and color of gladiolus blooms, and to help those who exhibit at flower shows, a numerical system has been devised. It is a three-digit system, and the number 520, for example, may appear after the variety name in a catalogue. This is how to interpret it:

The first number of the three digits identifies its size, *i.e.*, 500 indicates a giant size flower, 5½ inches or more across. The entire size range can therefore be indicated by these symbols.

Classification by size

100—flowers below 2½ inches across. Miniature
200—2½ through 3¼ inches. Small
300—3½ through 4¼ inches. Medium
400—4¼ to 5½ inches. Large
500—5½ inches and over. Giant

Classification by color

The next two digits indicate color, the smallest numbers being for lighter colors or tones, with the colors deepening as the numbers get larger. "Markings" simply denote blotches or areas of a second color in the heart of the flower.

00—White without conspicuous markings
01—White with markings
14—Light yellow
15—Deep yellow
20—Buff
24—Light orange
26—Deep orange
30—Light salmon
32—Deep salmon
36—Scarlet
40—Light pink
42—Medium pink
44—Deep pink
50—Light red
52—Deep red
54—Black red
60—Light rose
62—Medium rose
64—Deep rose
66—Lavender
70—Purple
76—Light violet
78—Deep violet
80—Smoky shades
90—Any other color

Guide to Reliable Gladiolus — by Color

Gladiolus varieties number in the thousands, and for this reason many people find it difficult to select a few kinds for their gardens. The following list groups some of the finest inexpensive varieties by color and here is a chance to practice on the classification numbers that indicate size of bloom and color intensity.

White (00)

Cupid (300)
Florence Nightingale (400)
Prof. Goudriaan (500)
Sierra Snow (400)
White Lace (300)
White Symphony (500)

White with markings (01)

Crusader (301)
Sparkling Eyes (401)
White Sails (401)

Green

Green Ice (404)

Cream (05-10)

Columbia (406)
Connie G. (506)
Leif Eriesson (506)
Lorelei (510)
Pixie (310)

Yellow (14-16)

Aureole (414)
Catherine Beath (316)
Forsythia (412)
Gold (412)
Gold Bank (414)
Golden Boy (316)
Prospector (414)
Sparkler (315)

Buff (20-24)

A. B. Coutts (520)
Pactolus (421)
Patrol (421)

Orange (24-26)

Daisy May (521)
Circe (523)
Fire Opal (426)
Ginger (426)
Orange Ruff (426)
Regina (524)
Valentine (425)

Salmon (30-32)

Boldface (532)
Cordova(432)
Chinook (532)
Dolly Varden (533)
King Size (531)
Polynesia (430)

Scarlet (36)

Carnival (437)
Dieppe (436)
Hilltopper (436)
Red Cherry (436)
Red Wing (436)
San Souci (436)

Pink (40-44)

Alfred Nobel (445)
Evangeline (540)
C. D. Fortnam (440)
Cotillion (542)
Maytime (442)
Pennant (440)
Spic and Span (442)
Sweet Sixteen (442)
Tivoli (440)

Roche

Best for arrangements are small-flowered gladiolus which, like the variety Flicker, have slender wiry stems, graceful, airy stalks

Red (50-52)

Garnet Ruffles (352)
Harrisburger (552)
Leah Gorham (451)
Mid America (550)
Mighty Monarch (552)
Red Charm (452)
Royal Stewart (450)

Black Red (54)

Ace of Spades (454)
Black Cherry (554)
Dark David (554)
Ruffled Ebony (454)

Rose (60-64)

Appleblossom (460)
Burma (562)
Joyous (464)
Elmer's Rose (460)
Magnet (562)
New York (564)
Noweta Rose (560)
Rosannah (563)
Rosario (461)
Rosita (563)

Lavender (66-68)

Bridal Orchid (566)
Elizabeth the Queen (566)
Francesca (566)
Heirloom (566)
Parthiena (568)

Purple (70)

Emperor (470)
Karen (471)
King David (570)
Lancaster (470)
Sherwood (570)
The Rajah (570)

Violet (76-78)

Abu Hassan (378)
Blue Devil (479)
Caribbean (376)
Mable Violet (470)
Pinnacle (577)
Ravel (477)
Salmon's Sensation (578)

Smoky

Copper Lustre (580)
Dusty Miller (486)
Stormy Weather (480)
Tan-Glo (480)

Any Other Color

Buckeye Bronze (490)
Cherokee (590)
South Seas (491)
Vagabond Prince (391)

Miniature and Small Gladiolus

Atom (236)
Baby Butterfly (226)
Cutie (241)
Daintiness (200)
Goldette (212)
Gremlin (251)
Lavender Petunia (269)
Peter Pan (233)
Pint Size (166)
Polar Cub (200)
Red Cap (236)
Statuette (211)
White Satin (100)

SELECTION AND CARE OF HOUSE PLANTS

Victor H. Ries

HOUSE plants, like babies and pets, require regular attention, and the more regularly they get it the better they will grow. The basic requirements of plants differ, one with another. The deserts, jungles, fields, woods and mountains of the world have furnished the great variety of plants we grow indoors and in greenhouses. To succeed with them, we must supply conditions of soil, temperature, light, humidity and soil moisture that are similar to what they had in their natural habitat. This is not always easy in the hot dry atmosphere and insufficient light of homes. There is the added problem of maintaining proper conditions in small containers.

Temperature. Most house plants do best at 70 degrees or slightly higher in daytime and at approximately 60 degrees at night. This is true of African violets, begonias, marantas, and other tropical plants. On the other hand, some plants require cooler temperatures of not over 60 degrees in daytime and 50 degrees at night. Included in this group are azaleas, cyclamen, primroses and other non-tropical plants.

Temperatures higher than normal tend to make plants soft, leggy and less attractive, and flowering plants may have few or no blooms. On the other hand, temperatures that are too low will stunt plant growth.

Light often is the major limiting factor in growing house plants. Some require more light than others, and most plants will grow better if we give them more light even though they survive with less. During the winter months, when the intensity of sunlight is less, it is often advisable to move plants nearer windows. African violets are sensitive to being moved from one location to another. Giving them more light, especially in winter, will often bring them into bloom. During the summer some plants sunscorch if given full sun, as, for example, African violets. Most tropical foliage plants, although they may grow in full sun, will nevertheless scorch if taken from indoors directly out into full sun.

Most plants, except cacti and succulents native to desert areas, require higher humidity than usually is maintained in homes. Since few homes have adequate humidifying systems, it is necessary to produce greater humidity in the vicinity

Often the simplest arrangements of house plants are the most effective. These plants frame window nicely, still get enough light

Gottscho-Schleisner

Leaves for propagating should be cut carefully, with sharp knife, from healthy plant

Watson from Monkmeyer

Leaf cuttings are now set in coarse vermiculite for rooting. Parent plant is unharmed

HOW TO PROPAGATE AFRICAN VIOLETS

of the plants. This is done by placing pans or trays of water, moist pebbles, sand or peat moss beneath the pots. Do not let the pots stand in water as the roots would be damaged. Instead, set the pots on bricks, blocks of wood, inverted pots or saucers or on gravel. The window sill above the kitchen sink often has a higher humidity. For orchids and other plants requiring high humidity, a small area may be enclosed with plastic or even glass. If in a window, be sure that the enclosure is adequately heated.

Watering. Some pots may need watering every day, and most plants at least every other day. Daily checking is good insurance. Keep the soil moist at all times but not muddy. When soil dries out until it is powdery, even if for only one day, the fine roots and root hairs die. The plant cannot start growing again until a new set of tiny roots is formed. Most desert plants, such as cactus, need not be watered more than two or three times per week.

Any water can be used if it is fit to drink. It is rare that the chemicals in water systems cause damage to plants. Never allow potted plants to set in saucers or pans of water for more than an hour or so. Large porous clay pots that are difficult to water may be placed in a pail of water for as much as 10 to 15 minutes to thoroughly soak them. The temperature of water used usually is not important, except that water colder than room temperature will discolor the leaves of African violets, gloxinias and similar house plants, if put directly on them.

Soil. The soil used for potted plants should be specially prepared. For most plants mix:

1 part leaf mold or peat moss
2 parts soil, preferably garden loam
1 level teaspoon complete fertilizer to each quart of soil mix

Use 4-12-8, 4-12-4, 6-10-4 or similar fertilizer. If a stronger fertilizer is used, such as 20-20-20, then reduce the amount to one level teaspoon to 3 quarts of soil.

Watson from Monkmeyer

Above left. Cutting is ready to pot when roots have formed and a new plant has started at the base of the stem

Above right. Use a pot about 2¼ inches across for each cutting. Set the cutting at slant, giving young plant space to grow

Right. Most cuttings produce a cluster of young plants instead of a single crown. When they reach this size, divide them

Bottom right. Several single-crown plants, now potted individually, have come from one cutting. Each will make a good plant

Gottscho-Schleisner

For woodland plants, such as begonias, ferns, African violets, use:
1 part leaf mold or peat moss
1 part sand
2 parts soil
Use fertilizer as recommended above. Always sift soil through a ¼-inch screen to take out coarse fragments.

Fertilization. Give plants fertilizer at least every two months from March through October. Do not fertilize during the winter months when there is not sufficient sunshine to enable the plants to make use of the nutrients. Any reliable brand of fertilizer may be used, such as

Agrico, Vigoro or other complete fertilizer. Apply at the rate of 1/4 teaspoon to a 4-inch pot—less for a smaller one, more for a larger one. With soluble fertilizers, follow instructions on the container. Soluble or regular fertilizers are equally satisfactory, if they supply nitrogen, phosphorus and potash. Bonemeal furnishes no potash; liquid manure contains only nitrogen. Liquid fertilizers are watered on the surface of the soil, while dry materials are scratched into the surface of the soil in the pot, and watered in.

Containers. House plants can be grown in a wide variety of pots and containers. They may be glass, wood, plastic, metal, concrete, glazed or unglazed ceramic material or old-fashioned red clay. Be sure the pots have drainage holes. For nonporous containers, such as glass or plastic, add somewhat more sand to the soil mixture to provide good root aeration.

Usually plants are put in containers that are just large enough to hold the roots. However, the smaller the pot the more frequent will be the need for water and fertilization.

Repotting is done only as the size of plant, from the esthetic viewpoint, requires it. Otherwise regular fertilization will balance the lack of more soil. Repotting usually is to a pot one inch larger in diameter. Standard pots have the same depth as diameter. Many plants do not need so much soil and are grown in shallower pots or "pans"—(they are clay, even if called "pans"). These are now available in all sizes.

When repotting, put a piece of broken flower pot over the drainage hole to prevent the soil from clogging it. Remove some of the soil from the top and bottom of the ball, replace this with fresh soil, put in the bottom of the pot, and press soil around the roots to within a half inch of the top. Repotting may be done whenever the plants are not in active growth. This will vary with each kind. Some prefer to do repotting just before putting plants outdoors for the summer.

Summer care. Vacation-time is hard

Select plants according to available light

Sunny Windows	*Medium Light*	*Low Light*
Amaryllis	African violet	Apostle plant (*Marica*)
Azalea	Anthurium	Aspidistra
Begonia, flowering (winter)	Aluminum plant (*Pilea cadieri*)	Aucuba
Cactus	Babystears	Chinese evergreen
Coleus	Begonias (foliage type)	Dracena
Crown of Thorns (*Euphorbia*)	Bromeliads	Fatshedera
Cyclamen	Dieffenbachia	Fiddle-leaf fig
Gardenia	English ivy	Grape ivy
Geranium	Episcia	Nephthytis
Hibiscus	Ferns	Norfolk Island pine
Impatiens (winter)	Gloxinia	Pick-a-back plant
Poinsettia	Maranta	Pothos
Primrose	Palms	Sansevieria
Rose	Rubber-plant	Schefflera
Succulents	Strawberry geranium	
Wax Plant (*Hoya carnosa*)	Wandering Jew (*Saxifraga sarmentosa*)	

Plants requiring cool temperature

Azalea	Cyclamen	Jerusalem cherry
Camellia	Forced bulbs	Lily-of-the-valley
Cineraria	Hydrangea	Primrose

Three Good Foliage Plants

Schefflera (*above left*). An excellent house plant that has glossy green, 6-inch leaflets borne at the end of each stem

Cryptanthus bromelioides (*above right*).The rosettes of ivory-edged leaves of this bromeliad are a rich bronzy green color

Ficus radicans variegata (*lower right*). An unusual variegated creeping fig which has been trained here against cork bark

Genereux

on plants when friends and neighbors must take care of them. Try putting all plants, even African violets, outdoors. Most plants will need some protection from sun so place them in the shade of a building, tree or shrub. Plunge the pots to their tops in the soil. To prevent damage to the foliage by slugs, use a prepared bait or dust with Snailicide at least every two weeks. Water several times a week using a rose nozzle or other spray to reduce the force of the water and so prevent damage to the foliage. Plants that can be given full sun include cactus and succulents but even they should be exposed gradually by shading with cloth or paper except for an hour or two, the first few days. They have to be gradually hardened to the sun just as we do when we go to the beach.

In early autumn, all tender plants should be brought indoors before night temperatures go down below 60 degrees. Azaleas can be left out until after a freeze.

Planter boxes attached to houses, either indoors or out, are a problem. Contractors generally fill them with the worst sort of soil. Indoors they are either in front of windows where the soil gets too cold for growth of tropical plants, or are in such dark places that

it is difficult to grow anything. The present trend to fill planters with soilless mixes (such as vermiculite) does not help since the materials used seldom contain any nutrients. However, regular fertilization is needed, whether the planting boxes contain soil or a soil-substitute.

Some plants can be grown in water alone, although a pinch of complete fertilizer once a month will give more healthy growth. To keep down algae in the water, use a colored glass or opaque container. Actually, the algae are harmless, but the green slimy appearance is not attractive. For water culture, try grape ivy, English ivy, Chinese evergreen (*Aglaonema*), philodendron, pothos, nephthytis, wandering Jew, Japanese spurge, and coleus Border Queen, sweet potato, German or parlor ivy.

Common House Plant Troubles

White cottony masses on the stems and leaves are an insect, mealy bug. None of the common sprays are effective. Wash off with a detergent on a soft brush. Alcohol on a bit of cotton on a tooth pick or a small tipped water-color brush, applied to each mass, will kill them. Then dust or spray plants every two or three weeks with DDT or malathion.

Grayish or brownish leaves may be due to spider mites which are barely visible to the naked eye. Use malathion, but keep DDT away.

Sticky stems and leaves may be due to plant lice (aphis) which are easily killed by aerosol sprays containing rotenone. Scale insects also leave sticky residue. Scrub off with finger nail brush and detergent. Then dust or spray with DDT to kill any crawlers that you missed or which may have hatched from eggs.

Leaves turning yellow and dropping may be due to improper watering, either too much or too little, or to plants standing in water.

Plants that are tall and spindly are probably suffering from lack of sufficient sunlight. Sometimes, also, from overdoses of fertilizer.

Gardenia leaves yellowing usually is due to lack of sufficient soil acidity. Insufficient nitrogen will cause similar symptoms. Also, repotting later than September will produce the same results. For lack of acid, give one-half cup a month of solution of alum or iron sulfate, made with one tablespoon to one quart of water. Bud drop during winter is normal.

Poinsettia leaves yellowing and dropping is due either to chilling or a lack of sufficient water or sunlight.

Christmas cactus flower buds dropping probably is caused by over-watering.

African violet leaves wilting usually is due to over-watering, or from salts accumulated on edge of clay pots. Flowers dropping is due to illuminating gas in air.

Amaryllis not blooming usually is the result of insufficient foliage and lack of adequate growth during the previous summer. Plant bulbs directly in the ground outdoors in full sun as soon as weather warms in spring and leave them there until the first frost in fall. Pot up and take indoors.

Cyclamen leaves yellowing may be due to lack of water, lack of sunlight or high temperature. They need water every day.

Edges of leaves turning brown usually is due to improper watering, either too much, too little or too irregularly.

Rex begonias have richly marbled leaf patterns in many colors from silver to burgundy. They grow well in north windows

Singer

FORESIGHT IN PLANTING

How to plan a peaceful, distinctive garden with interesting pictures and vistas—without too much work

Alfred C. Hottes

EVERYONE desires to live in a gardened home of which he can be proud. The most modest house and even the house of poor architecture can be completely transformed by a simple planting. How can the planting be properly started?

The best way for a beginner is to hire a competent landscape architect who has devoted his life to the study of plants and knows just how tall each one grows, how coarse or fine its texture, and how adaptable it is to soils, wind, and moisture. Competent nurserymen also know most of these facts and are willing to advise.

If the homeowner is to do all the planning and work himself, he must make frequent trips of observation. He must study the grouping of shrubs and trees in parks and botanic gardens, along the streets, and in the yards of his friends. If he makes notes on the plantings that please him, he is more likely to buy wisely. He will be making a picture, using plants instead of paint.

The poorest way of landscaping the home grounds is to look through a nursery catalog without a plan in mind and then blindly choose plants without knowing how many the place will accommodate.

The usual home gardener becomes a hopeless inebriate when he visits a nursery or scans a catalog. It is a common practice for persons to plant everything the neighbors will give them; and some believe that as long as there is a square foot of soil not covered by some form of vegetation there is still room for a giant forest tree.

It is only the extremely abstemious home buyer who can resist planting an apple, a pear, a plum, a peach, and a grape vine in his back yard, for they all look so innocent when young. If they all grow, the result is usually a hopeless hodgepodge of insect-ridden plants, for it would take a very experienced gardener to spray them all properly and keep them in healthy condition. Planting too many fruit trees eliminates the possibility of having any choice flowering annuals, perennials, or shrubs; and the planting becomes so unsatisfactory that the gardener soon loses his interest in gardening. He would be overworked if he took proper care of all his fruits, and dissatisfied with the disorder if he neglected them.

A weed is a plant out of place. Any plant put into the ground and not placed properly is a weed, even though it is a fifty-dollar magnolia tree put into the usual dollar hole. Most people bring home new plants after every foray upon their friends' gardens; then they begin to wonder where to put this loot.

This article cannot go into details about the planting of the home grounds but it can outline a few general suggestions.

Keep the Planting Simple

If the garden needs six plants of one kind, do not buy thirty others for which there is no place. Staggering figures could be compiled on the money wasted in unwise planting every year.

Make a Plan Before Planting

Have an idea in mind. Do not dash around the yard planting hit and miss as if the shrubs and trees were dropped from an airplane. Keep the new trees and

shrubs in a wheelbarrow until the place for each one is evident, to complete a carefully thought-out picture. The plants are much easier to move in the wheelbarrow than when they are well rooted in the ground.

Make One Picture at a Time

Do first things first. Set off the doorways with appropriate plants. Hide unsightly views. Enhance beautiful vistas.

Remember that Plants Grow

Everyone expects and wants plants to grow, yet few persons visualize the final effect. The average person shops for bargains, purchasing young trees to plant in front of the house; and when these grow rapidly into forest-size trees, the buyer is disappointed and complains to the nurseryman that his place has become a hopeless jungle. Some persons consider it a bargain to buy an inexpensive vine and plant it where it will hide good architecture.

Plan for Both Enclosure and Spaciousness

Plant the lot so that the garden is part of the house, with rooms, windows, and space. Begin the planting at the margins of the property, to achieve enclosure for peace and quiet; but do this adroitly so that there is no feeling of being smothered by the walls. If the lot has no view, make one. From the principal windows or doors make a path leading to a garden feature—a fountain, a pool, a seat, a well branched picturesque tree.

Strive for Pleasing Forms and Lines

Flat surfaces give a feeling of peace but they may become monotonous; undulating lines give rhythm to the landscape.

The perfect globe form to which some shrubs are pruned is a disturbing element in the landscape. A pyramid is the most exalting form; but a series of pyramids reminds one of a coarse-toothed saw. It is like the forbidding wall with bits of broken bottles stuck into the concrete; yet many persons are insensitive to this and plant the foundations of their homes with a serried row of pyramidal conifers. It is true, however, that attractive groupings of three or five clustered pyramids can be made to give the effect of one.

Make the Planting Interesting

How to achieve an interesting garden is in each person's hands as an artist or an innovator. A surprise of some sort makes a planting more interesting; but do not litter the yard with rows of strange rocks, toy ducks, and windmills. The garden should be peaceful and should not be filled with objects that do not belong there.

Plan So as to Avoid Too Much Work

Attempting too much always brings disappointment. It is better to have a patio planned with charm than a thousand-acre estate that is a wilderness of weedy beds and disheveled lawns.

Shrubs and trees take the minimum of care—water, feeding several times a year, an all-purpose spraying less than once a month, and a little snipping now and then.

Annuals are much more work; they need to be sown from seed; they are inclined to be crowded by weeds, and soon they must be replanted to avoid a yawning gap in the landscape.

Make the Planting Distinctive

Gardens cannot be all alike, for some people like lilacs while others prefer azaleas. One likes formality and preciseness, another likes the winsome ways of Nature. Someone is provoked if he hasn't masses of color at all seasons of the year; he is, therefore, delighted with zinnias, while someone else is happy only if he is trying to grow a rare species of rock plant. No, gardens will never be sold by the gross. People are not alike.

Study the Plants

One who wishes to do good planting must know the plants and their habits. An interest in plants is an abiding one. Don't lose heart at the number of trees and shrubs in the nurseries.

Part II — Garden Practices

HOW TO DIAGNOSE GARDEN TROUBLES

Victor H. Ries

BEFORE any garden problem can be corrected, or plant damage prevented or controlled, it is necessary to know the cause. Sometimes this is very evident, but more often it is not. In the latter case, expert help is needed which can be had from county agents of your state agricultural service, some garden centers, botanical gardens and professional horticulturists. Unfortunately, all too few local salesmen handling pest control materials are trained diagnosticians, or even experienced gardeners. In any case, no one can prescribe a cure without seeing the damaged plant, the pest that causes it or, in some cases, without having a soil analysis.

The Causes of Trouble

Before blaming an insect pest or disease, check the following possible causes, one or more of which may be to blame.

The soil. Has it been properly prepared by adding at least 5 per cent organic matter? Has sufficient fertilizer been applied to maintain adequate growth? If not, growth may be stunted. Has too much fertilizer been used so that the roots have been damaged? This may produce scorched edges on leaves, and in more severe cases the plants wilt and die. Putting fertilizer in the bottom of a hole without thoroughly mixing it with the soil before setting in the plant is a common cause of damage. Applying more fertilizer than recommended on the package may injure plants. Letting fertilizer stay on the foliage may burn it. Always wash or shake off any fertilizer that falls on the foliage.

Acid-soil plants, such as azaleas and rhododendrons, will have yellowish leaves with darker veins and few if any flowers if the soil is not sufficiently acid. In some localities, but not nearly as many as suspected, the soil may be too acid so that most plants will be stunted and sickly looking. Liming will correct the situation. In the same way, soils that are too alkaline because of over-liming or which are naturally alkaline, as in some western states, may stunt and even kill some kinds of plants. Wherever soils are naturally alkaline one should grow mostly lime-tolerant plants. However, such plants as azaleas and oleanders can be grown in alkaline soil treated with iron chelates such as Sequestrene.

Soil moisture is often a limiting factor. More often an excess of water causes the trouble. Lack of moisture is often a problem where either competing roots absorb moisture or it cannot fall naturally, as under trees and shrubs, beneath over-hanging eaves, between buildings and in sandy soils. Artificial watering must be done more frequently under such conditions.

Sunlight is necessary for plant growth. Some plants require all-day sun to thrive.

Without it they may not bloom or grow as well as they should. On the other hand, some plants cannot stand full sun and must be given protection, and they, along with shade-tolerant plants, are best used in shade plantings. (See lists on pp. 15, 90)

Climate. All too often we try to grow plants that are not adapted to our climate and although they may survive a few years, in less congenial seasons they may be damaged. For example, the evergreen magnolia of the South is being grown in many places in the North where it is never likely to live to a ripe old age. Many azaleas now being shipped from the South to northern gardens may also prove to be tender.

Temperature is often a limiting factor. Low winter temperatures will damage or kill plants that are not completely hardy. This damage may not be apparent until early summer, as is often the case with roses and broad-leaved evergreens. Sudden drops in temperature, especially in the fall before plants are sufficiently hardened, may damage them. High summer temperatures will restrict growth of some plants, whereas cold summers will limit the growth of more tropical plants, many annual flowers, and such vegetables as corn, melons, squash and tomatoes.

Wind is sometimes a limiting factor. Broadleaf evergreens and some needled evergreens (hemlocks) may be so dried by wind that the leaves scorch. The corners of a house, the narrow place between buildings, wind-exposed hilltops and open country are likely places for wind problems. Wind hitting a building and bouncing back may cause more damage than normal. All wind damage is usually worse on young plants before they have become well established.

Chemicals. Over-doses of chemicals used in the control of insects and diseases may damage the foliage. When the temperature is over 85°, many dusts and sprays will burn even when used at the recommended strengths. Sulfur is especially dangerous to plants when the temperature is over 85° F.

Another unexpected source of trouble is from careless use of weed control chemicals. Many of these are difficult to remove from the sprayer, so a separate sprayer is advisable. The drift of herbiside dust or spray onto particularly sensitive plants may do more harm to them than to the weeds themselves.

The use of fly and mosquito sprays

In preparing spray mixtures, add the measured amount of pesticide to a small amount of water first. Stir until thoroughly mixed. Then pour into spray tank, add water to proper level, agitate before and during spraying

Roche

containing oil is almost sure to burn some plants.

Insects pests are sometimes easily seen but all too often they are not visible. Seedlings disappearing, holes in leaves and flower buds eaten may indicate that slugs are working at night. Stems cut off near the ground may be the work of cutworms which hide in the soil by day. Stunted plants may be caused by root aphis. Since the control of insects is a broad subject it would be well to consult authoritative garden books and also the "Handbook on Plant Pests and Diseases," published by the Brooklyn Garden.

Plant diseases may be caused by a specific parasite as well as by unfavorable growing conditions. Diseases on the surface of a plant are easy to see and diagnose. But all too often the disease organism is in the inner tissues of the plant or on the roots where it is not easy to observe. This usually calls for professional help to diagnose the cause and prescribe a control.

Equipment for pest control

The gardener can take his choice between spraying and dusting. Dusting is usually easier and quicker although dusts are not likely to be as effective as properly applied sprays. The home gardener seldom has the equipment to do a really good spraying job. The most efficient sprayer should give at least 100 lbs. pressure, have a 5- to 10-foot hose, a 3- to 6-foot spray rod and a nozzle with an elbow. Small knapsack sprayers, although convenient, do not meet these specifications. Small hand atomizers are neither efficient nor effective for more than a house plant or two.

Dust guns of one or two quart capacity are easy to operate, relatively inexpensive and long lasting. Larger models with bellows or with cranks are available for use in larger gardens.

Precautions to follow in pest control

1. Cover all parts of plants, especially undersides of leaves.
2. Do not dust or spray when plant is wilted.
3. Do not dust or spray when temperature is over 85°, particularly in direct sun.
4. Do not mix different dusts or sprays unless recommended by manufacturer.
5. Measure all amounts accurately; overdose may damage plants.
6. Keep all pest control materials labeled, out of reach of children.

Light-weight dusters are now available which greatly simplify the task of caring for roses and other flowers. This one holds about one pound of dust; blower is operated with crank. At least 20 rose bushes can be dusted with one filling

Gottscho-Schleisner

7. Use soap or detergent in sprays if recommended. These are "spreaders."
8. Prepare all spray mixtures fresh before using.
9. Wash sprayer thoroughly after use; some spray materials are corrosive.

Materials to use in insect control

Aramite—mites

Chlordane—most insects except mites and aphis. Also for slugs, earthworms, grubs, ants, chiggers. Use dust or spray.

DDT—most insects, except aphis and mites. Use dust or spray.

Lindane—most insects. Dust or spray.

Malathion—most insects including mites and aphis. Dust or spray.

Methoxychlor—effective against insects on beans, gourds, melons, squash. Dust or spray.

Nicotine sulfate—mostly for aphis. Spray only.

Rotenone—mostly aphis and other soft-bodied insects. Dust or spray.

Materials for disease control

Arasan—seed treatment. Dust.

Captan—most diseases except powdery mildew. Dust or spray.

Ferbam—same as for Captan.

Karathane—also called Mildex. Mostly for mildew.

Sulfur—largely replaced by captan and ferbam except for mildew. Dust or spray.

All-purpose materials

It is usually more convenient for the home gardener to buy all-purpose mixtures than to attempt to mix his own. A number of these are on the market, sold under various trade names. The several different chemical components are always given on the package. Two common formulations are: ferbam, DDT, rotenone, aramite and sulfur or karathane; also, captan, malathion, DDT, and karathane.

Materials for general insect control

Ants—chlordane

Earthworms and Grubs—chlordane ½ lb. 50% to 1000 sq. ft. or 1 pint 45% emulsion to 4000 sq. ft. You can garden just as well without the earthworms. Besides, they destroy all the expensive organic matter you so carefully mix with the soil.

Plant lice (aphis)—malathion, rotenone, nicotine sulfate

Leaf hoppers—DDT, malathion

Scale insects—mixture of DDT and malathion, apply as eggs hatch. Usually this is in spring, but varies with each kind of scale.

Caterpillars—DDT, malathion, chlordane

Lacebugs—DDT, malathion

Whitefly—DDT, malathion

Thrips—DDT, chlordane, lindane

Mealybug—malathion

Wireworms—Lindane

Slugs—metaldehyde in prepared baits or in snailicide

Sowbugs—chlordane

Cutworms—DDT

Fleabeetles—DDT

Spidermites (red spider)—malathion or aramite. Do not use DDT because it kills other insects feeding on mites.

Leaf miners—chlordane, malathion, DDT

Bagworms—malathion (DDT would increase spider mites on evergreens)

Spray tanks may now be rolled about in the garden instead of being carried. This one, having 6 gallons capacity and 14-inch wheels, is worth trying as a labor-saver.
Universal Metal Products

HOW TO MANAGE GARDEN SOILS

THE soil in lawns and gardens is seldom satisfactory for plant growth without proper preparation. It is, however, less costly to modify the soil that one has than to replace it with so-called top soil. All too often purchased soil is no better, and sometimes far worse, than the existing soil. Besides, new soil often introduces more weeds and pests into the garden.

Good drainage is important for good growth of most plants. Poor drainage means that water has replaced the all-important air in the soil, which smothers the roots. Roots require air just as much as do leaves. Some plants are more sensitive to this than others. Roses, cherries, yews are but a few plants that are seriously damaged by wet soils. Depressions that hold surface water, and downspouts from the roof that are not connected to drains are two common sources of trouble.

The only satisfactory method insuring adequate drainage of heavy soils is the installation of lines of agricultural drain tile to carry excess water to a lower level, a drain or storm sewer. Using 4-inch tile, set 12 to 18 inches beneath the surface, with the lines of tile 25 to 30 feet apart, will be sufficient. Allow an inch or two of drop for each 100 feet of line. There is no need of worry that this will dry out necessary moisture because it only removes the excess.

The use of rocks, stones, bricks or cinders in the bottom of a flower bed, which is so often recommended, does not remove water from a heavy soil; it merely makes a good cistern to hold it.

Proper grading of the soil surface is helpful but does not always solve the problem. Hillsides can be poorly drained if there is a layer of hardpan or impervious clay beneath the surface.

All too often, black muck is sold as peat. It runs about 40 per cent organic and as such is relatively worthless for soil conditioning or any other garden or lawn use.

Techniques for Improving Soils

Organic matter in the soil is all-important. Most soils do not have enough of it for the best growth of plants. There should be at least 5 per cent organic content, and for most plants 15 or even 20 per cent will give even better results. In other words, it is almost impossible to have too high an organic content. Often, the addition of organic matter to the soil gives better results than an application of fertilizer. The reason for this is that with better soil aeration, there is greater root growth. Clay soils, especially, need more organic matter to improve drainage as well as aeration. Sandy soils need it to increase their moisture-holding capacity.

The easiest and least expensive method of incorporating organic matter is to grow it. A "green manure" crop of winter wheat or rye may be sown, one pound to 1,000 sq. ft., in late August or September to be plowed, dug or rototilled under the following spring. In the spring, as early as possible but as late as late June, rye grass may be sown. This is turned under in late August. It is advisable to apply a complete fertilizer, such as a 4-12-4, 5-10-5, 5-10-10, 6-10-4 or something similar, at the rate of 20 lbs. to 1,000 sq. ft. when the seed is sown and again just before it is turned under. This later application hastens decomposition. It is amazing how much these methods aid in loosening even the heaviest soils. Nothing else does as well as the millions of tiny roots of these grass plants.

When green manuring is not possible, various forms of organic material may be purchased and mixed with the soil. If you spade, about three spadings may be necessary to obtain a good mixture to a depth of about a foot.

Inorganic materials, such as sand, fine cinders, and coal ashes, are not nearly as effective as organic. Besides they do not furnish the materials needed by micro-organisms in the soil to carry on their all-important work.

Organic matter varies greatly in price, so it pays to consider carefully what to buy. Barnyard manure is the traditional thing to use but usually it is more expensive than other forms. Unless fresh, it contains little actual fertilizer value, but in any event it can still be a good soil conditioner. All too often, manure contains a variety of weed seeds which may become pests.

Peat is usually the least expensive material available. Most of it is weed-free, odorless, disease- and insect-free. It is available in compressed bales of varying size, as well as in bulk. Since it varies in moisture content, weight is not a good basis for comparison. Cubic content is equally confusing. So it comes down to comparing, bushel for bushel, how much loose fluffed-up peat you get per dollar spent. Peat moss runs from 85 to 95 per cent organic.

Other organic materials suitable for improving garden soil are sawdust, shavings, straw, old hay, rotted leaves, buckwheat hulls, shredded bark, peanut hulls and other materials available locally. A layer of any of these materials, dug into the soil when preparing the garden each spring, will improve its structure. If any of these materials are more or less decomposed, they may be used without danger of plant starvation caused by the soil bacteria taking most of the soil nitrogen while decomposing them. If they are not decomposed, fertilizer containing nitrogen must be applied. This same problem occurs when mulching plants with any undecomposed organic mulch. It also occurs when growing seedlings or plants in paper pots, even in waxed paper milk cartons.

Organic matter added to soil is broken down and used by soil organisms so it is necessary to replace it every few years. This is one reason why it is necessary to do over flower beds and borders and repot house plants. As this organic matter is destroyed, it leaves the soil darker. Too many gardeners believe that dark soil is richer and better than light colored soil. This is not always true. Nor is a black woods soil usually rich. This is just another of those old fallacious garden beliefs.

What to Know About Fertilizers

Most soils are lacking in one or more elements necessary for plant growth. The three most important of these are nitrogen, phosphorus and potash. Other elements sometimes lacking are magnesium, manganese, boron and iron. The latter, and others are called trace elements. Rarely must they be added to the soil because most of them are present as impurities in commercial fertilizers. There are localities where one or more may be the limiting factor in plant growth. Consult your county extension agent or state experiment station for advice.

State laws require that the analysis must appear on every fertilizer package, giving the per cent of available nitrogen, phosphorus and potash, expressed in this order as 4-12-4. Since soils vary from one place to another, even in the same garden, and since it is not possible to know the exact requirements of each and every kind of plant, the best one can do is give them all a balanced diet. Usually, one kind of fertilizer may be used on everything, without fear, for the plants can not read the labels!

If a fertilizer contains nitrogen, phosphorus and potash it is called complete. If the components are chemicals it is an inorganic or commercial fertilizer. If it is made up of plant or animal products, it is organic. Except that the chemicals are often more quickly available than the organics it really makes no difference to

Gantner

All kitchen waste, weeds, other organic matter can be returned directly to the soil with the trenching method. Fresh soil covers the material when the next trench is dug

Roche

Winter rye, sown in the fall, is ready to dig under in spring when planting time arrives. Turn the clumps over so the tops are buried. Add fertilizer before planting

How to Improve Garden Soil

Compost is the most convenient source of humus in most gardens. Spread a heavy layer over the ground before doing the final digging. All organic matter lightens soil

Lime may be added once every few years, which will correct over-acidity and loosen clay soils. Lime or fertilizer can be spread and dug in at the same time with compost

Use of lime, alte
nate layers of soi
fertilizer and wat
will hasten decomp
sition of compos
Old compost pile
in rear, new one i
foreground

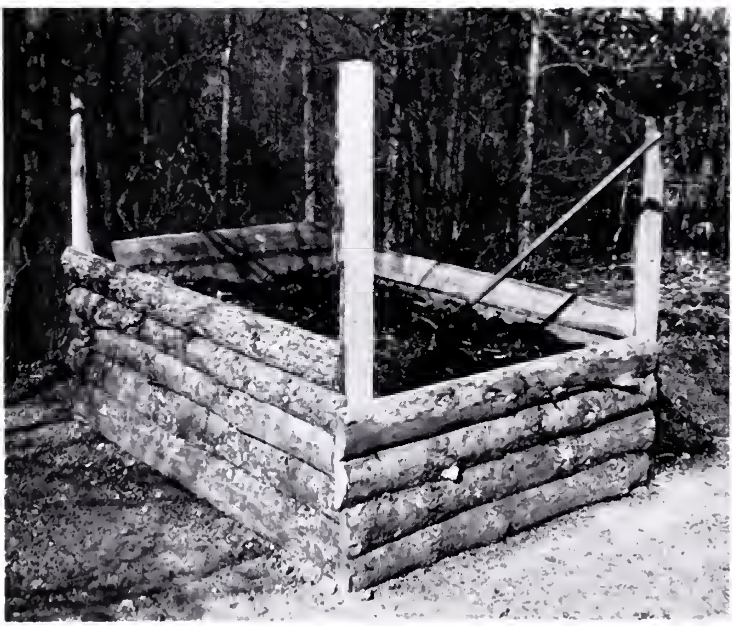
Gantn

the plants, the claims of organic gardeners to the contrary. Once the nutrients are dissolved in the soil so that the plants can use them, the elements available to nourish plants are the same. Chemical fertilizers are usually cheaper than organics.

A commercial fertilizer is required to contain at least 20 units of nutrients as indicated by the analysis. Many organic fertilizers contain considerably less, yet actually cost more per pound.

Ordinary commercial fertilizers, though soluble in the soil, are but slowly soluble in water so are usually applied dry. Although nitrogen and potash dissolve and leach down into the soil rather quickly, phosphorus penetrates but a scant inch a year. For this reason it is well to mix the fertilizer with the soil at time of planting. Never put any fertilizer in direct contact with the roots for they may get burned.

Special fertilizers are available today



Compost bin
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Roc

that are quickly soluble in water. In these, the phosphorus penetrates the soil to reach the lower roots. Many of these fertilizers have a high analysis, containing as many as 60 units of nutrients. Typical analyses are 19-28-17; 23-21-17, 20-20-20. Dissolved in water and used according to instructions, they are perfectly safe. But to use them as you would a dry fertilizer is dangerous because of their greater concentration. The same is true of the 10-10-10 and 12-12-12 farm fertilizers now available. They can be used if mixed with the soil but often burn if put on top of the soil where plants are growing.

Plants soon exhaust the nutrients in the soil. Nitrogen and potash both leach away, and so must be replenished at regular intervals. Seldom do we apply them as much, or as often, as plants can utilize. Fertilizer once dissolved in the soil moisture moves downward only, never laterally. Consequently it must be spread uniformly over the entire surface of the soil. Every square inch should receive its share. This is easy to do with a spreader on lawns and other areas where no plants are in the way. Otherwise, the fertilizer must be spread by hand. It may take practice to do this evenly. Weigh out a pound and spread it on a patch 5 by 5 feet. This will be at the rate of 4 lbs. to 100 square feet, which is the maximum recommended for a 20 unit nutrient commercial fertilizer, such as a 4-12-4.

Gardens should be fertilized every spring, preferably before growth starts so that there is little danger of burning foliage. For most garden flowers, a second application may be made in June and a third in September. The roots of plants take in the nutrients as long as the soil is not frozen.

Soluble fertilizers will take up moisture and ruin the package unless they are kept in glass or plastic so moisture can not reach them. It is best to buy only enough to last one season. They are used dissolved in water at recommended rates to fertilize flower beds, lawns, and other ornamental plants during the growing season.

Singer

Shrubs and evergreens in borders need less weeding and are not likely to get dry when mulched with old hay or straw

Consult the HANDBOOK ON SOILS for complete information on soil, and good soil management.

Home-made rigs, like this one of wooden slats and chicken wire, speed the task of carting dry leaves to the compost pile

Gantner

BE A COMPOST MAKER

Conrad B. Link

ORGANIC matter is an essential component of good soil. It is not a permanent part of the soil and so must be renewed continually. In the garden this organic matter may be supplied as manure or as compost. Animal manures are not easily obtained and are expensive, especially in or near large cities, and so most gardeners must use other types of organic matter. Peat is one of the well known types, easily handled and readily obtained. Local products useful for gardens are sometimes available, such as humus, shredded redwood bark, shavings, buckwheat hulls, ground corn cobs, and shredded sugar cane. They are not all of equal value, and some of them are better adapted for mulching purposes than for immediate incorporation into the soil.

The Home Compost Pile

The efficient gardener can produce much of the organic matter his soil needs by composting plant refuse—making artificial or synthetic manure. It is not difficult. A compost pile does not take up much space but should be hidden from view. Leaves provide the major garden waste material useful for composting but other materials may also be used, such as straw, hay, shavings, lawn clippings, and nongreasy kitchen waste.

Usually, a compost pile is built up gradually as materials become available. The first step is to make a layer of the **plant refuse** about 6 to 12 inches thick. (Diseased or insect-infested material must not be used but should be burned.) On top of this a light layer of **lime** should be sprinkled, and a complete fertilizer such as 4-12-4 or 5-10-5. About 50 pounds of **fertilizer** and 25 pounds of lime are sufficient for a pile of 125 cubic feet. The fertilizer provides nitrogen, which is needed by the bacteria of decomposition. This nitrogen later becomes available to the plants. Phosphorus and potassium also are changed in such a way as to become more readily avaliable to plants. **Lime** prevents the decaying material from becoming too acid, and provides more favorable conditions for bacterial action. The amount of lime used is not enough to produce an alkaline reaction, and so the compost may be used for plants that need an acid soil.

As more material becomes available, **more layers** with lime and fertilizer are put on, until the pile is 4 to 5 feet high. It is important that the material be moist enough to encourage decomposition. As the pile is built, each layer should be **watered**; and the entire pile should be watered in dry weather. The completed pile should have a depression on top, to catch the rain. Some gardeners put a sprinkling of manure or garden soil over each layer to add more bacteria.

After two to three months it is desirable to **turn over the compost pile.** This will help to aerate it and to mix the materials at the outside of the pile with those on the inside and speed up total decomposition. Large piles built up all at once may heat rather quickly inside. This high temperature is often sufficient to kill many disease and insect pests.

During the summer usable compost can be made in four to five months. Compost made in the fall requires a longer time. The nature of the materials used also affects the time of decomposition; soft green plant material decomposes more quickly than dried leaves.

Home composting is an efficient and practical way of utilizing garden refuse —**burning is wasteful** of good materials.

GROWING YOUR OWN PLANTS

Victor H. Ries

GROWING plants from seed, and rooting cuttings, is so easy that no longer need any one say, "I do not have a green thumb, so cannot grow my own plants." A small nursery bed where small plants do not have to compete with big ones pays dividends in increased growth. And every good gardener should have at least one coldframe for starting plants; before long you will have several and wonder how you ever got along without one. A coldframe well filled with husky plants is the sign of an outstanding gardener.

The use of sterile, weed-free, non-compacting mixtures will give results most of the time provided they are kept watered and not too hot. A mixture of equal parts sand and peat is ideal. Some seeds give improved germination and early growth if shredded sphagnum moss is used. Other sterile materials are vermiculite and perlite. In any case, a 1-inch layer of this material, placed on top of a screened mixture of equal parts soil, sand and peat, is foolproof. Thus the seeds germinate in a disease-free medium, but can extend their roots into a growing medium. Cover seeds with sand and peat sifted not over one-eighth inch deep with a soup strainer or fly screen sieve. Covering may also be done with the sterile mediums alone. Sowing may be in 3- or 4-inch clay pots plunged in sand, in shallow flats, or seed trays available from garden supply stores.

Outdoor sowing in a coldframe usually gives better plants than indoor sowing. A sash-covered frame may be used and seeds sown when pussy willows are in bloom. Transplant seedlings when an inch or so high to flats or directly into the soil in the frame. Space them one to two inches apart. Seed flats and seedlings may require watering every day. It is the drying out that does the damage. It is difficult to over-water a porous seedbed mixture.

Seeds of many woody plants, such as trees and shrubs, must be sown in the fall so as to have a couple of months of below-40-degree temperature before they will germinate. This also applies to bleeding-heart, trollius, many wild flowers and some rock plants. If in doubt, fall-sow in November. This can be done with all hardy perennial flowers and with hardy annuals as well. In most cases a 3-inch pot is ample for home use. For labeling use India ink, put on painted wood labels with a #6 speed ball pen. It is much better than even a label pencil.

Rooting cuttings of hardy flowers, evergreens, shrubs and house plants is much easier and surer if coarse vermiculite (Zonalite) is used. It does not stay too wet as may peat or the finer garden grade of vermiculite. Clean, sharp sand is also good but takes a little more experience to use. Coarse perlite (Per-loam) is also used. As soon as roots on cuttings are one-half inch long, transplant to prepared soil. Again try soil, sand and peat, equal parts instead of the regular soil in the garden. Covering the flat or pot of cuttings with plastic, held above the tops of cuttings with wire frame, greatly reduces care.

All sorts of plants, such as coleus, geraniums, chrysanthemums, fuchsias, impatiens, bedding begonias, may be grown from cuttings taken from indoor plants in late winter, or from garden plants in spring. The cuttings need not be more than 3- to 5-inch pieces of the ends of new shoots. Cut bottom leaves from the cuttings and set the lower half of the stem in the rooting medium. If the material is loose, press it around the stems. Water overhead when the cuttings are in place, using a fine spray.

Roche

Cuttings of many shrubs and vines may be made when shoots stop growing in early summer. Remove the bottom leaves

Singer

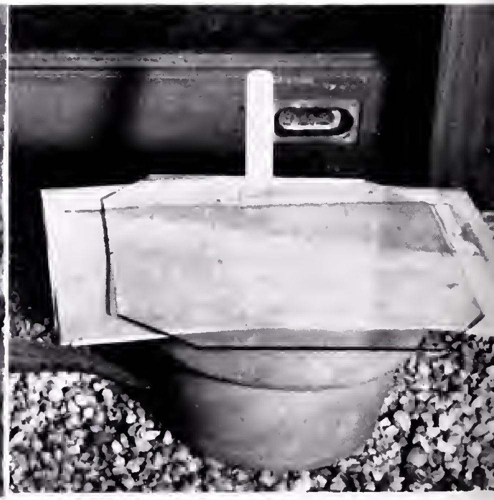
Cuttings root with least care in box of rooting medium, and covered with polyethylene film—pulled back in photo to show cuttings

Cuttings must be kept from wilting either by covering the container and cuttings with a sheet of plastic, or keeping them out of hot sun and drafts. A small, glass-covered box or frame, which can be shaded, is an ideal place. Leave the cuttings in the medium only long enough to root. Within two or three weeks, test a few by pulling them lightly. If they are rooted, they will not come up easily. Transplant cuttings when ready to flats, shallow boxes, individual pots of clay, plastic or pressed peat, or into a frame or nursery bed. Transfer the new plants into the garden or window boxes when weather conditions are right.

RAISING PLANTS FROM SEED

Seeds sown in vermiculite in clay pots may be watered by setting them in pan

Drying before germination is prevented by covering with newspaper and a sheet of glass



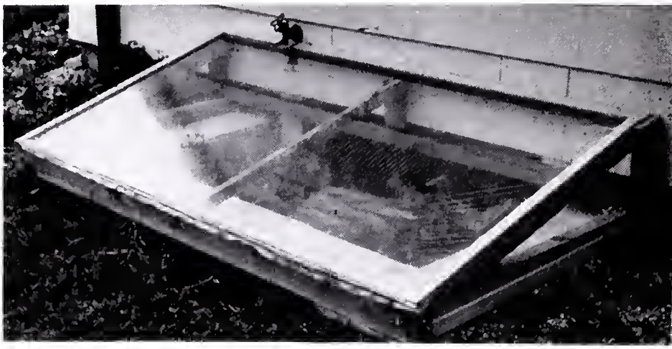
Seedlings grown in pressed fiber pots, such as "Jiffy-Pots," root through the pot and suffer no transplanting shock in the garden

Singer

New strawberry runner plants, which have made their own roots, may be taken from parent plants in spring to start a new bed

A window well or cellar areaway may be converted to a temporary greenhouse for starting seedlings in spring by fitting it with a wooden frame covered with a sheet of polyethylene film

Gantner



After the seedlings are up, the glass and paper are removed. These seedlings are now big enough to transplant to flats or pots

Lettuce seedlings being transplanted into the garden from a coldframe can be evenly spaced by using a marked measuring stick

Roche

TOOLS AND EQUIPMENT FOR GARDENING

GARDEN maintenance is less work and more enjoyable when well-kept tools are carefully stored and near at hand. Experienced gardeners equip themselves with quality tools and clean them immediately after each use. The edges of spades, shovels, hoes and trowels are kept keen and smooth with a file or grinding wheel. Rusting is prevented by never leaving tools outdoors. Garden tools often hold greater interest for the user if handles are painted a bright color. Avoid lending tools, especially shears, saws and power equipment, which are easily damaged.

Quality tools are easier to use than cheap ones because they have better design, balance or "hang." A good tool, if properly cared for, will last for years or even a lifetime.

Most garden tools are long established designs that have proved themselves over the years. Very few worthwhile new ones have been put on the market, but many poor ones have been.

The following tools are of greatest use to gardeners:

Shovels are still needed for moving soil and other material. A short-handled, round-pointed one is most useful, unless you expect to dig deep ditches.

A **spade** is handy for digging and balling evergreens, and turning soil. It is more useful than a spading fork. The standard blade is about 7 inches wide and 12 inches long. A small spade with a blade about 5 by 10 inches is nice for handling small plants.

Steel rakes are essential for leveling soil, or smoothing it after spading. The back of a rake is as frequently used as the side with the teeth. For leaves a steel spring leaf rake is good. Wooden rakes break easily although bamboo rakes last well with care.

For handling trash, prunings, leaves, a long handled pitch or **manure fork** with four or five tines is good.

If soil is so hard that a pick or mattock is needed, it is much too hard to plant in. The little **army pick**, available in surplus stores, is a most handy tool for breaking up hard soil.

With the increased use of mulches, there is less and less need for the many and varied hand cultivators. But if needed in a vegetable garden, the **wheel cultivator** is an efficient tool.

Hoes, likewise, are of more use to "old timers" who have the urge to cultivate everything. The little onion and scuffle hoes are fun to use. The lighter they are

Roche

Sturdy, clean, sharp tools, conveniently stored, are a great aid to efficient gardening

the better. But, plants will grow just as well without cultivation—if well mulched.

What trash is sold in the name of **trowels!** Yet excellent steel, stainless steel and aluminum trowels are available. Get a short-shanked trowel since heavy digging can be better done with a spade or shovel.

A metal-bodied **wheelbarroy** will give a greater range of use than the old fashioned wooden kind. The bigger the wheel the easier it is to push. Little metal garden carts are nice but they do not supplant a wheelbarrow.

In **pruning shears** you get as much as you pay for. The best are wonderful and so much easier to use. For over pencil-sized branches use a **lopping shear.** Again get the best. For over 1-inch branches use a **pruning** saw. Try the pull type with fish tail teeth. Some come with curved blades and cut on the pull rather than the push stroke.

Power cultivators have their limitations; they can cultivate but it takes great power to plow to the necessary depth.

Clear **plastic hoses** are much lighter to handle than the rubber kind. For watering seed beds and small plants, use a **rose spray** that delivers a fine spray without any force.

To supply the necessary 1 inch of water a week to gardens, hand-held hoses are out of the question. There are many inexpensive, but serviceable, oscillating **sprinklers** on the market. They fit into the shape of the average lawn plot better than the rotating type. Three to four hours of watering in one place is enough.

Efficient pest control requires good equipment. A 2-quart **dust gun** is inexpensive and lasts for years. For **power sprayers,** get one that delivers 100 pounds pressure, has a 6- to 10-foot hose, and a 3- to 6-foot spray rod. The average little knapsack sprayer will not do this.

Inexpensive **watering cans** are a nuisance for they do not deliver a fine spray. A good can, available from the large, mail order seed companies, costs over ten dollars but is a lifetime investment. It has a long spout and both a fine and a coarse sprinkler face.

To avoid arguments with borrowers, either paint all tool handles a distinctive color or paint or brand your name on them. Garden tools do have a way of roaming and not returning, especially if they are good ones.

The garden cart, pictured here, is one of several models available, in which soil and garden refuse can be moved with the least work. Light - weight garden tools, next to the bench, are just right for a woman to handle

Gottscho-Schleisner

PRUNING ORNAMENTAL PLANTS

Kenneth W. Reisch

PRUNING consists of the removal of a plant part or parts to improve the health, appearance or usefulness of the plant. Pruning provides the means of preventing, correcting or improving undesirable growth. But, failure to use recommended techniques often leads to despoiling a tree or shrub. For instance, there are some who feel that unless a large brush pile is created, the job is unfinished. At the other extreme, there are those who feel that a plant will be damaged if even the necessary amount of pruning is done.

In order to prune correctly, consideration should be given to such factors as the rate and habit of the plant's growth, specific pruning techniques recommended for the plant, and the desired end result.

Pruning is work, and the trend in modern gardening appears to be toward a reduction in maintenance. The necessity for pruning can be considerably reduced by selecting the proper tree or shrub for the location. Those which are not entirely hardy, or which will grow too large for the location, or tend to be vigorous and become quickly overgrown, or are inclined to have a lot of dead wood or become unsightly with age, should be kept to a minimum in the landscape plan. The wide availability of many plant types in nurseries today has enabled the home owner to consider these factors when buying plants. Thus, proper selection of trees and shrubs can minimize the need for pruning.

Here are some of the specific situations which good pruning practice can solve:

1. Control of undesirable habit of growth.
2. Removal of dead, broken, or disease- and insect-infested branches.
3. Inducing more compact and sturdy growth by removal of certain branches even though healthy.
4. To produce a desired formal shape or size.
5. Improvement of flowering and fruiting by proper thinning or removal of old branches.
6. To better the chances of survival at transplanting time by reducing number or size of branches.
7. To retain maximum color in colored-twig shrubs by removing old branches.

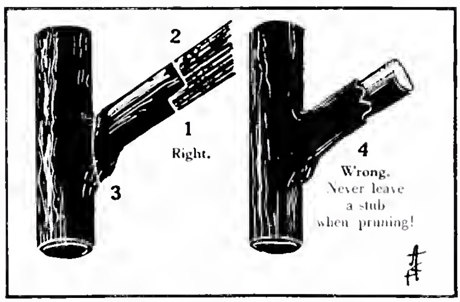
The proper time of pruning is often a question and, in general, from the standpoint of plant growth, pruning can be done at practically any time of year. However, one must consider such factors as food supply, flowering period and winter hardiness. The operation can be harmful if new growth is removed in the spring. A deciduous plant manufactures food during the growing season which is stored in various forms in roots and stems over winter. This food is the reserve energy supply for new growth and if the growth is removed before new food can be produced, growth may be stunted for the season.

With most plants, the ideal time to prune is during the dormant season before new growth starts. Some flowering shrubs are exceptions and this is indicated under the shrub pruning section.

The method of making pruning cuts is of great importance. Most rapid healing of a wound occurs when the cuts are made flush with the adjoining branch. When even small stubs are left, healing is prevented, the stubs die back and disease and rot organisms gain entry to healthy tissue. The same problem occurs when branches are broken instead of cut off. Cuts of terminal shoots should be made just above a bud.

Proper care should be given to large pruning cuts to facilitate healing. The

Breaking off the tip of a branch (pinching it), as shown *above*, stimulates the growth of more branches, as shown at the *right*, and prevents the plant from growing too tall



How to remove a large branch. Make cuts at (1) and (2) first, to prevent skinning the bark down the tree. Make the final cut (3), nearly parallel to the trunk, so that a stub is not left, as in (4), which will rot

wounds should be shaped by carving to a point at top and bottom and all wounds larger than one inch in diameter should be covered with a tree wound dressing. House paints or paints with a lead base should never be used. "Tree paint" is available from all good suppliers to the horticultural trade.

The general procedure to use in pruning any plant is to follow this schedule.

1. Remove dead, broken, and disease- or insect-infested branches.
2. Remove branches which cross or are detrimental to the shape and appearance of the plant.
3. Use the pruning procedures specified under the plant types that follow.

Specific procedures for pruning different types of plants are outlined under the following headings.

Pruning Established Plants

Shade Trees

1. Remove branches interfering with foot or vehicular traffic.
2. Thin out top to open internal branches to light.
3. Do not cut central leader unless absolutely necessary.
4. If possible it is better to make two small rather than one large cut.
5. Call in a recognized arborist for work in high places—the chances are that you are neither trained nor conditioned to do high pruning.
6. To prevent tearing bark, cut any large branches as indicated in sketch.

Flowering Trees

1. Prune after flowering.
2. Follow recommendations indicated under shade trees.
3. Thinning top will increase flowering; however, a heavy cut-back may reduce or eliminate flowers for a season.

Shrubs

1. Don't simply trim back top, thin out

plant by cutting older branches back to ground.

2. Prune often and reduce necessity of heavy cut back.
3. Some shrubs such as forsythia, mockorange, deutzia, and spirea can be cut back to the ground when it is necessary to rejuvenate old plants that have grown too large or are mostly "old wood."
4. In order to retain flower buds, shrubs such as forsythia, lilac, mockorange and garland spirea should be pruned shortly after flowering.
5. On shrubs with colored twigs, such as red and yellowtwig dogwood, about one-third of the older wood should be removed every year to retain maximum coloration.
6. Remove old flowers of shrubs such as lilac, rhododendron, hibiscus and magnolia to maintain optimum flowering for the next season.

Narrowleaf Evergreens

1. With the exception of pines, most narrowleaf evergreens should be cut back the desired amount in early spring, prior to growth.
2. When branches are cut back hard, leave some foliage on the remaining part. One exception to this is yew which will grow from a severe cutback, though this is not generally recommended because the plants will be unsightly for two or three years.
3. Pines are "thickened up" by pinching off part of each new shoot, the "candle" growth which comes from the buds at the beginning of the growing season.
4. Yearly pruning is required in order to maintain a compact habit.
5. It is common practice to shear evergreens with a hedge shear and thus obtain a severe, formal plant. More interesting, semi-formal plants can be obtained by pruning individual branches with hand shears.
6. Evergreens should be occasionally thinned out to open inner branches to light.

Broadleaf Evergreens

1. Relatively little pruning is necessary with plants of this type with the exception of rules 1 and 2 under general pruning recommendations.

With a little practice, hedges may be given even, smooth trim with electric clippers

Roche

High branches of small trees, tall shrubs, vines are within reach of the pole pruner

Gottscho-Schleisner

Vines and Ground Covers

1. Some deciduous vines require occasional heavy pruning or complete cutback.
2. Prune vines to keep them out of windows or other similar areas on structures.
3. Ground covers may require pruning to keep them within bounds or to rejuvenate plantings.
4. Little pruning is necessary on many of the evergreen ground covers. Exceptions are some kinds of euonymus, English ivy, spurge, and creeping mahonia.

Roses

1. Follow rules 1 and 2 under general pruning recommendations.
2. Cut remaining canes back to 18 to 24 inches in height.
3. Prune hybrid teas, floribundas, and grandifloras prior to growth in the spring.
4. Prune climbers after flowering.

Hedges

1. Prune prior to growth in spring and again in summer to remove feathery new growth.
2. Prune annually to retain size and shape.
3. Prune to shape so that base of hedge is wider than the top. This allows light to reach the lower branches and prevents legginess.

Pruning Plants for New Plantings

Shade Trees

1. When moving bare-root, prune broken and dead roots and cut back tops in proportion to the size of the root system.
2. When pruning the top, cut back lateral branches, not the terminal.
3. When moved with a ball of soil, only light top pruning is necessary or desirable.
4. Remove weak, V-shaped crotches when tree is young.

Forsythia. *Above*, in need of pruning. All older branches of large diameter should be removed, i.e., cut back to ground. *Below, left*, properly pruned with numerous graceful branches that will flower heavily. *Right*, improper pruning has destroyed graceful form and good blooming qualities. Prune in early spring or right after flowering

Shrubs

1. When moved bare-root, remove dead or broken roots, and cut back branches.

Evergreens

1. All evergreens should be moved with a ball of soil. Little or no top pruning is necessary.

Roses

1. Prune dead or broken roots.
2. Cut top back to 10- or 15-inch height.
3. Remove thin, spindly or crossing shoots.

HOW TO PLANT A TREE ......

Directions applicable to trees up to 5 inches in diameter. . . .

Time to plant. Fall or early spring.

Preparation before planting.

Roots

Do not allow to dry.

Soak in pail or tub of water if they seem dry when received.

Protect with moist burlap or cover with moist soil in a shallow trench (*heel in*) if unable to set plants out at once.

Cut back cleanly to firm wood with knife, if broken or bruised.

Tops. Prune off some of the branches, to compensate for unavoidable loss of roots in digging up. This will prevent excessive evaporation through leaves later.

How much to remove

In general, about one-fourth to one-third of the secondary branches.

Entire branches—rather than clipping off ends of branches. Include among these the branches that form tight or weak crotches.

Crowded or rubbing branches.

Do not cut main leader.

Hole (see diagrams below)

Twice as wide and deep as roots.

Several inches of manure or humus mixed with soil in bottom of hole, and covered with several inches of soil.

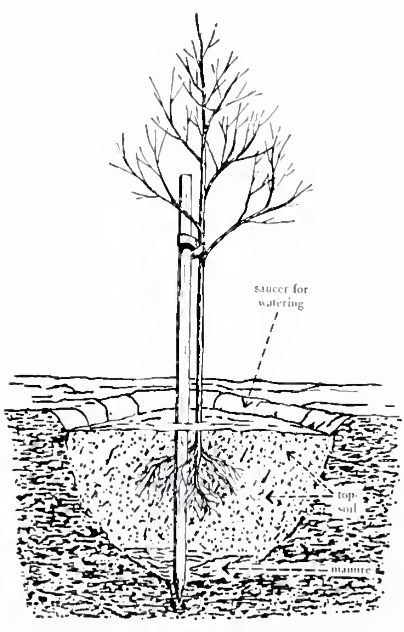
Planting

Trees (see diagram below)

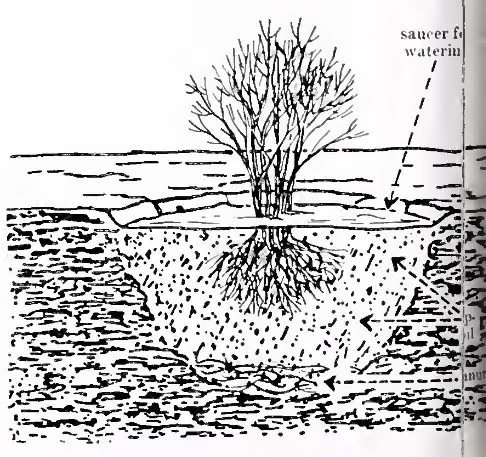
Drive stake near center of hole, well down into solid earth.

Set tree at same depth as before, or an inch or two deeper—not more.

Place trunk vertical.



How to plant a young tree



How to set out a shrub

. . . . . . OR A SHRUB

. . . . or shrubs up to 5 feet tall

Shrubs (diagram on opposite page)

Set at same depth as before—no deeper.

Place branches so that whole plant is well balanced.

Trees and shrubs

Spread roots out in hole.

Fill hole with good topsoil.

Pack soil as it is filled in.

Tramp it with the feet after roots are covered (see drawing below).

Make it so firm that plant cannot be pulled up.

Wash it into crevices among roots with gentle stream of water from hose or watering can.

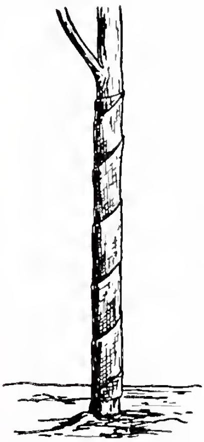
Leave saucer-shaped depression around plant—2 inches deep—for catching rain water and for watering (diagram opposite).

Mulch ground over hole with peat moss or salt hay, or other material several inches deep, to prevent excessive evaporation.

Later Care

Wrap trunks 2 inches or more in diameter with burlap or heavy paper, as shown. Leave on for two years, to protect trunk from sun scald and from attacks of insects.

Water plant adequately during first two years. In dry weather fill saucer-shaped depression with water three times at each watering, letting water soak in throughly before refilling.



Trunk wrapped with burlap or paper

Packing soil firmly over roots

Part III — Lawns

LAWNS—THEIR MAKING AND KEEPING

Robert W. Schery

LAWNS are not so puzzling if viewed as populations of grass plants which have the usual plant requirements for growth and survival. Simple reasoning then suggests timing and frequency of fertilization, steady mowing—not so severe as to cut away portions of vital green leaf—seasonal weeding to lessen competition for the grass and other practices appropriate for the kind of grass planted.

Today even the most amateurish lawn owner can procure effective, ready-to-use products, with the directions for use simply stated on the package. Laborious practices have fallen before science and research.

Soils and Seedbed

Lawn making, like any gardening, is helped by good soils. But a little extra attention can make up for poorer soil, so don't be disheartened should your lawn be upon subsoil from a basement excavation. Fertilizer and grass roots can turn this into "topsoil," and in most cases purchase of topsoil is not necessary.

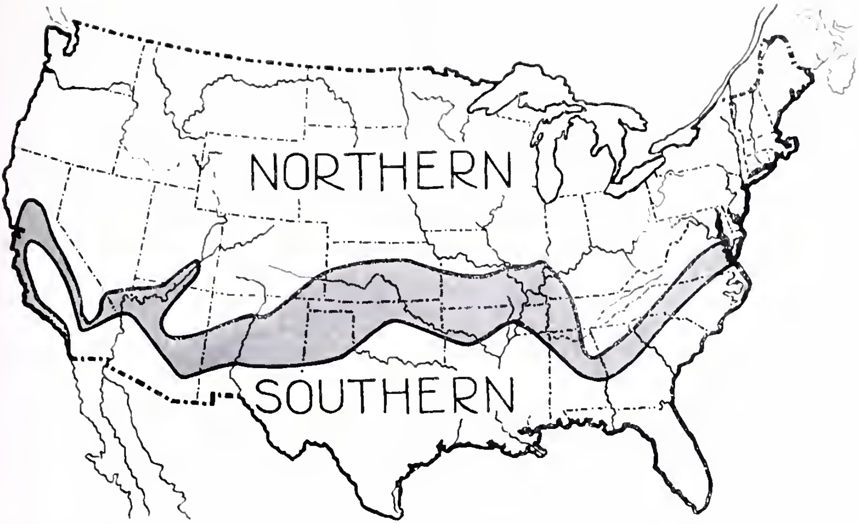
For a new lawn, till the soil several inches deep, breaking up the compacted layers. Grade and rake level, with the land sloped for drainage away from the house. Avoid steep slopes, impoundments, obstructions that will be in the way of mowing convenience. The surface need not be pulverized; in fact a dusty fineness will cake, inhibiting sprouting and leading to soil wash.

Incorporate ample plant food. This is the last chance to get fertilizer into the root zone without disturbing the grass. Almost any complete fertilizer is suitable, but especially should phosphorus be mixed in. Phosphorous is "fixed" by soil, will not move readily downward from the top. Twenty pounds of 12-12-12, or something equivalent, to 1,000 sq. ft. is not a heavy rate for most seedbeds.

Choice of Grass

Next comes the all-important choice of grass. The kind of grass will determine the appearance of the lawn, and guide maintenance practices. The map divides the nation into northern and southern zones. Each is dry west of the Arkansas-Minnesota line, and in the western plains and basins supplemental watering is needed for a good lawn, although some of the native prairie grasses may survive and make acceptable cover.

For the northern area there are three main grasses—Kentucky bluegrasses, red fescues, and bentgrasses. Bentgrass requires extra attention, and is best left to the specialist. Kentucky bluegrass and red fescue have similar growth habits and make good companions. The bluegrasses do best in open situations and on good soil, while the red fescues are adaptable

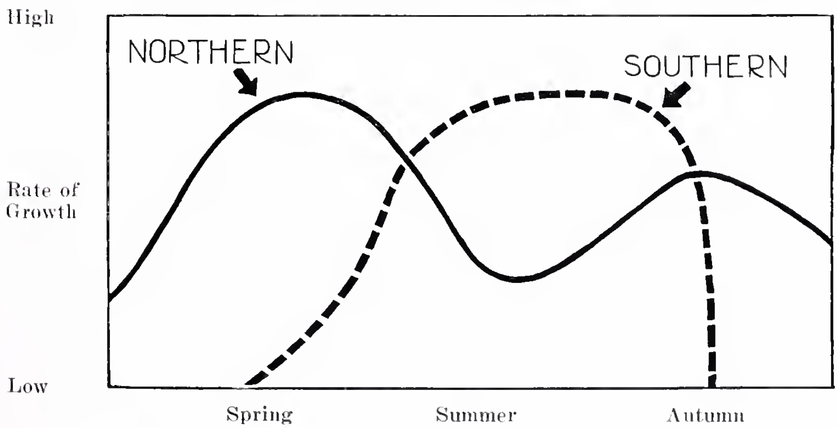


Lawn Regions. Either northern or southern grasses may be planted in the shaded area. North and south of this band, only grasses suited to the climate should be used

to shade, sandy soils, and under trees. Thus a mixture of mostly Kentucky bluegrass with red fescue offers both good and poor soil species of proven worth for fine lawns.

The short-lived ryegrasses and coarse tall fescues (Kentucky 31 and Alta) are frequent ingredients of inexpensive mixtures. They are quick to sprout, but smother the slower permanent grasses. With mulching commonly practiced nowadays, there is little need for quick nurse grasses in a seed mixture. Reject seed mixtures which contain more than a very minor per cent of rye grass, and don't use tall fescues at all for fine lawns

Lawn growth cycles. The solid line represents a typical northern lawn of Kentucky bluegrass; the broken line, southern lawns such as Bermuda or Zoysia. The southern line can also represent summer weeds in a northern lawn; the northern line, winter weeds in a southern lawn



Watering should be done thoroughly. *Left*, light sprinkling induces shallow rooting. *Right*, thorough soaking promotes deep rooting where subsoil moisture lies

(although they do have a place on athletic fields and, perhaps, rough areas).

Northern Lawns

The graph (p. 73) shows the seasonal cycle of growth of Kentucky bluegrass. Bluegrass lawns pick up very early in the spring, grow intensely through May and June, slow down in the heat of summer, then thicken up from September to November. This cycle offers clues for bluegrass lawn management.

Since northern lawns prefer cooler months, and find the heat of summer trying, fertilization and weed control would ordinarily best coincide with the seasons of opulence. Autumn fertilization, 10-20 lbs. to 1,000 sq. ft. once or twice from August through October, will build reserves for strong spring turf.

Spring brings another surge of growth, and fertilizer applied early will be of advantage to the grass then. Mow frequently, as much as every four or five days in the spring, so that never more than an inch of clippings is removed. Sudden scalping sets back the grass plants.

In later spring and early summer, hot weather weeds like crabgrass invade. If the lawn mower is set sufficiently high these weeds usually can be stalled. Crabgrass won't grow in the shade of bluegrass mown 2 to 3 inches tall, a height recommended for the southern part of the bluegrass zone such as Tennessee. In northern areas where the summers are more tolerable, Kentucky bluegrass can be mown as close as an inch. The broadleaf weed controls (with 2,4-D) are appropriate as the weather warms, say from April on. Sprouted crabgrass might have to be hit with the arsenates any time through late spring and summer.

Southern Lawns

The seasonal pattern of warm weather grasses is the dotted line of the graph. These include the Bermudas, Zoysias, St. Augustine, Centipede, Carpet, and Bahia—and for that matter the main weed of northern lawns, crabgrass. Growth picks up as spring warms, as early as February in the deep South, not until May in the Ohio Valley. With reasonable moisture and fertility southern grasses flourish during the heat of summer. Then as the cold weather and shortening days of autumn approach, they again turn dormant, becoming an unsightly brown in areas having a prolonged winter.

The growth of the southern grasses shows that maintenance is best timed almost the opposite as for northern lawns.

Planting and fertilization are preferable as spring warms, continuing through the summer. Watering, feeding, and weeding are most useful in summer when these grasses are most active (in the North feeding in summer can often favor the weeds more than bluegrass).

Seeding or Planting

Northern lawns are mostly seeded, a familiar practice that needs little discussion here. It is best accomplished with a mechanical distributor which will spread from 2 to 4 pounds of seed per 1,000 sq. ft. uniformly. To assure against missed areas, sow one-half in one direction, the other half at right angles. For less accurate hand sowing it is often desirable to bulk the seed with cornmeal or similar inert material.

After sowing, a light mulch will protect the soil, retain moisture to hasten sprouting. Familiar mulches are straw—three or four straws deep, soaked sphagnum moss, wood chips, loose netting, or even a plastic cover (for small areas).

In the South, common Bermuda, Centipede, Carpet, and Bahia are available as seed. The elite lawngrasses, improved Bermudas and Zoysia, must be planted from live shoots, since seed does not come true. St. Augustine also must be planted live, there being no seed. Centipede is planted both from seed and as sprigs.

Vegetative plantings are made from small sod plugs or rooting stem sections set at intervals into the newly prepared seedbed. Details on planting can be procured from nurseries supplying the cuttings. The new plantings must be made quickly to prevent drying out, and watering must be frequent until the new sod is established.

Watering

Constant moisture is vital to sprout seed or start new sprigs. Established and well fertilized turf rarely dies from lack of water. Of course, during summer drought grass tends to brown, and then watering determines whether the lawn will be green or not. Obviously, watering can help the weeds as well as the grass.

Mowing

Bermudas, Zoysias and bents have low trailing growth, can be mowed rather closely (usually $\frac{3}{4}$ to 1 inch). Bluegrasses, the fescues, St. Augustine, Carpet and Bahia prefer somewhat higher mowing (1 to 3 inches; the more difficult the climate, the more is high mowing apt to help the grass). Centipede is intermediate.

For close mowing, reel mowers usually are preferred; they do a precision job.

Sphagnum peat moss, spread over a newly sown seedbed, is very retentive of moisture, will promote quick sprouting and prevent crusting of the soil

7 Basic Steps to Having a Good Lawn

1. Prepare a good seedbed for a new lawn, amply fertilized.
2. Choose quality grass—bluegrass mixtures in the North, sprigs or seed of choice in the South.
3. Mulch the seedbed with peat moss after seeding, then water regularly until the new grass is established.
4. Mow whenever the grass grows an inch, and keep it mowed (high in difficult climates).
5. Fertilize generously, especially at seasons of greatest grass growth.
6. Weed if needed, by hand or chemically. If the latter, follow product directions carefully.
7. Above all, plan procedures so as to not overtax time or budget, so that you can really enjoy having a lawn.

For more detailed instructions on lawns, see the HANDBOOK ON LAWNS (the 1956 summer issue of PLANTS & GARDENS).

More versatile, and especially useful for higher mowing, are the rotary mowers. Space does not permit mower discussion, but keep in mind that most lawn maintenance time consists of mowing; get a sturdy mower that makes this time pleasurable—not an undersized, underpowered machine that is balky and has frequent breakdowns.

Other Lawn Care Tips

At least three pounds of actual nitrogen per year (almost 30 lbs. of a 12-6-4 per 1,000 sq. ft., or 15 lbs. of a 20-10-5) is recommended for lawns. The newer ureaform fertilizers are better at heavier rates, but need not be used as frequently.

There are numerous products for checking insects and diseases, fortunately not too often of concern in lawns. Sometimes grubs give trouble in northern lawns, and chinch bugs on St. Augustine in Florida. Such insects may be treated with chlordane or dieldrin.

Leaf spot may strike in cold wet weather of spring; it can be forestalled with antibiotics, mercurials and other preventives. Summer diseases are especially prevalent on bentgrass, and are treated with the same chemicals. Merion bluegrass is susceptible to rust, for which there is no cure, but which shows less when heavy fertilization forces new leaf growth.

Rough grass growing next to tree trunks can be cut with the rotary type mowers

Gantner

Part IV — Home Landscape Design

HOW TO USE PLANTS AROUND THE FRONT OF THE HOUSE

Donald J. Bushey

ROBERT BURNS may not have been thinking about landscaping when he wrote the often quoted lines,

"O wad some power the giftie gie us
to see oursel as ithers see us"

but the phrase can well be applied to the way our property looks to our neighbors and to the passerby.

The phase of home landscaping described here, the planting done near to the house foundation, is of great importance because it may make or break the appearance of the home as it is seen from the street. Yet, it is often done with little understanding of the problems involved; disappointing results are all too common.

The directions given here are strictly for the amateur who is going to do his own designing and his own work. Emphasis is given to plantings that will be in keeping with a variety of one-story to two-story houses.

There will always be differences of opinion as to the kinds of plants to be used. Some prefer narrow-leaved evergreens, some want flowering shrubs, and still others use a combination of the two. Narrow-leaved evergreens will provide green color through the year with some variation in the different varieties. Flowering shrubs will have bare stems in winter, some of which are very colorful, but will give an informal effect, as well as life and color to the planting during the summer. Broad-leaved evergreens, where they may be grown successfully, will be green throughout the year and give some flower color in spring. With these facts in mind each home owner should use the plants of his choice.

The best appearance of any particular house when the plantings are mature is subject to individual differences of opinion; what one person likes another disapproves. Some persons feel that few plants, if any, should be placed near the house. There is merit to this idea, particularly if the house is architecturally well designed and is in a setting of spacious tree-shaded lawns or if the house has large wall areas of glass. Other persons hold the view that many shrubs are needed, particularly around a house not well designed, which may need masses of plants to screen the imperfections. For most situations, a compromise between the two extremes may be best.

Fit the Planting to Style of House

Probably there is better reason for more planting around the base of a house having a high foundation wall exposed above the soil line than there is around a house with low foundation walls. A large-growing shade tree placed 15 to 20 feet from the corner of a house minimizes rather effectively the high appearance of a house that is narrow and upright. Plants with a horizontal branching habit help, as do structural devices such as window boxes, window blinds,

Author photos

Figure 1. A one-story house with little of the foundation showing can be effectively planted with just a few plants. Plants at corners may grow to the eaves

Figure 2. A balanced planting is appropriate for both a one-story and a two-story house. The corner plants in this case extend to the second story window sills

and two-tone painting. Horizontal lines reduce the apparent height, while narrow, upright plant forms increase the visual height.

Regardless of the kinds of plants to be selected, they should all be chosen and planted in positions where they will not be too large for the area when they mature. Most home owners can get agreeable results by working with enlarged photographs, beginning with a picture of the front of the house and then views of the other sides. Drawings, made to scale, of each elevation of the house can be used with equal effectiveness. In either case, place a piece of tracing paper over the photograph or drawing and, with a soft pencil or crayon, block in the various foliage masses you think will look best. In general, the foliage masses described here will be best for the houses illustrated in figures 1 and 2 and modifications of the same ideas can be used for different situations. Sketch these foliage masses in as they are described in the following paragraphs. They will form the main framework for your plantings.

Usually it is best to have low-growing shrubs at the sides of the doorway, somewhat symmetrically spaced (Figures 1 and 2). All entrance plantings, however, need not be symmetrical. If there is an unbroken, large wall space at one side of the door, a tree-form shrub or a vine (Figure 3) might fill that space and provide an attractive variation from the more usual design.

The plants to be used at the corners of

Figure 3. A trained vine or a shrub, pruned to an informal shape, is good for a large, unbroken wall space to the right of the front door

Figure 4. Only low plants should be used at corners where there are windows

the house usually should be tall-growing types, unless there are windows there. The corner planting for a one-story house may be of shrubs that will grow about as high as the eaves (Figure 1)—a little above or a little below would be satisfactory. For a two-story house the corner planting may reach the second floor window sills, a little more or less (Figure 2). In either case, if there are windows near the corner, tall-growing plants should not be used in front of them (Figure 4). Sometimes small-growing trees, those that will grow 15 feet high or a little more, are planted effectively at a house corner, usually at a somewhat greater distance from the house than the shrubs (Figure 5).

In the case of a split-level house, taller-growing shrubs or small trees may be used at the high corners and the low corners may be treated as is suggested for a one-story house.

What planting is done along wall spaces will be governed largely by the length of that wall and the location of the door, windows, and wall spaces. Uninterrupted wall spaces, several feet wide, between a door and a window or between two windows, may need a foliage mass somewhat higher than the window sill (Figure 6). Sometimes a small-growing tree is planted beside a window to provide shade, to block the view from the street into the room, or for some less obvious reason, such as variety from the more usual design (Figure 7). If either of these plantings is located somewhat to one side of

Figure 6. *Above.* A shrub of medium size when mature is in proper scale to plant in front of a large wall space between windows

Figure 5. *Left.* A small-growing tree will effectively supplement a low-growing shrub at the corner of a house

the wall space, it will usually be more interesting than one set exactly in the middle. Also, the length and height of each wall space will be the clue for the kind and number of plants to be used. A large wall space usually will require more plants and taller-growing ones.

In situations where a driveway or sidewalk near the side of the building leaves a planting space too narrow for shrubs, ground covers can be used to fill the area, and height can be obtained by using a vine or an espaliered tree or shrub. A twining vine or an espaliered plant may be used near a wall of wood construction and a clinging vine on a masonry wall, including a chimney.

Any planting done below windows should be of material that will grow less than the window sill in height. If the house is low, with little foundation wall showing above the soil line, the grass might extend to the foundation wall, a low ground cover might be used, or shrubs of a mature size that will not shade the window excessively or block the distant view from the room inside.

In general, comparing the planting to be done near a one-story house and a two-story house, both with symmetrically spaced door and windows and with only low foundation walls exposed above the soil line, the planting across the front of each could be very much the same in mature effect. The corner plantings for a two-story house would be taller-growing material than that for a one-story house. (Figures 1 and 2). If, however, these same two houses had high foundation walls showing above the soil line the plants to be used across the front of the house might better be chosen from a group that would grow a little taller—about the height of the window sill.

Following these simple directions prepare two or three sketches of each side of the house—front, sides, and back—and for the wall plantings. This will give you an opportunity to choose the one which appears most pleasing to you.

Planting Under Eaves

Planting under wide, overhanging eaves presents something of a problem but not

Figure 7. A small-size tree will shade a large window in summer, also help break the view from the street into the house

a serious one. Many of the plants used will be planted beyond the overhang of all except very wide eaves and many will even grow satisfactorily without getting direct sunlight, so the choice of plants for such situations is quite varied. Of greatest importance is an adequate supply of moisture. Preparing the planting soil with large amounts of organic material such as peat, keeping a mulch under the plants throughout the year, and watering the soil with a hose before it becomes dry will keep the plants growing thriftily. Organic material and mulch will conserve moisture, and only infrequent watering will be necessary.

When the sketch you select is completed with the foliage masses blocked in, you can measure on the wall of the house the actual size you want each plant to be at maturity. Many nursery catalogues give the mature height of each plant and other data. Plant lists obtained from other sources, such as your State College of Agriculture or a botanic garden, often arrange the plants in size groups. Select the plants you know and like, or if you do not know many varieties, go to a nursery to see plants that may interest you. Visit with experienced friends who have planted their properties with a variety of material, and ask their advice. Learn all you can about plants—their characteristics such as color of flower or fruit, autumn foliage color, as well as mature size.

Consider Plant Color

Be careful about selecting plants with bright flower or foliage color. Use colors that will harmonize with the color of the house. The yellow flowers of forsythia and Harison's Yellow rose are not so effective near a house painted yellow as they are near a white house, but they will repeat satisfactorily the color of yellow trim. It is inappropriate to use the red rugosa rose or the magenta flowered Anthony Waterer spirea near a house painted red or near one constructed of red brick, but shrubs with white or yellow flowers are excellent against brick. Highly colored plants, red and yellow leaved varieties, those with variegated foliage, or bright-colored flowers should be used with great restraint. They will attract undue attention to themselves and detract from the rest of the scene.

It is customary for nurseries to have available several sizes of each variety they grow. In general, a shrub 3 to 4 feet high will cost more than a $1\frac{1}{2}$- to 2-foot shrub of the same variety because of the longer time and more labor required to produce it. Because the larger plant gives a more nearly immediate effect, some home owners are willing to pay more for it. However, in a few years the smaller size will produce the same effect as the larger one. Probably most home owners buy medium-sized plants, as they produce a reasonably good appear-

ance when they are planted, have a good root system, stand transplanting well, and are moderate in cost.

When very small sizes are used, the new planting appears sparse and inadequate, but if the plants purchased are proportional in size to their mature character the general effect of the new planting will be suggestive of their appearance after several years' growth. If only a limited number of mature or semimature shrubs is to be used, preference should be given to those planted near the front part of the house so a good appearance from the street is evident immediately.

Proper spacing (often several feet apart) of small-size shrubs exaggerates the sparse appearance of the planting, but the final results will be well worth the waiting. If they are spaced close together for quick effect, they will soon crowd each other, become misshappen, and have to be removed. Then the planting must be done all over again with the lesson of proper spacing learned the hard way. Some of the crowded plants in the original planting, if they are not too badly damaged, may be left where they are, giving them more room by removing the nearby poorer ones. Or they may be used elsewhere on the property. To minimize the initial sparse effect of a properly spaced planting, annuals or ground covers may be used in the open spaces, between the permanent plants. As the longer-lasting plants gain in size, the amount of space left for annuals becomes more and more limited until they are eliminated by the maturing shrubs and evergreens.

Spacing the Plants

Twining vines and clinging vines are usually listed in nursery catalogues according to their age and a two- or three-year-old plant is a good size to order. They should be planted as close as possible to the wall they are to grow against, one vine being enough for a small trellis. Those to be grown on a long fence should be planted 10 to 15 feet apart. Clinging vines are appropriately used on a masonry wall, one for a small wall, and a spacing of 15 or 25 feet apart for a large wall. Seldom should a wall be completely covered with vines as a lacy effect is more attractive.

Ground covers such as myrtle and pachysandra are sold as clumps and are

Only low-growing plants, requiring a minimum of pruning, will remain dwarf and so not obscure the window or become out of scale in a raised planter box

Genereux

This planting has been kept simple purposely, so as not to detract from the design of the doorway and brick paving pattern. Conical-shaped hollies with English ivy ground cover frame the door; tree is locust

Molly Adams

planted 12 inches apart for a good effect in about a year, 2 feet apart if you are willing to wait 2 or 3 years for them to fill in. Vines and prostrate evergreens usually are planted 3 or 4 feet apart. Vines are bought by age and prostrate evergreens by the measured spread of their branches. Some spreading perennials such as cottage pink and goldentuft are planted from 2 to 3 feet apart.

Low-growing shrubs from 1½ to 3 feet high when full grown usually are classified in nursery catalogues by the height of the plant when they are purchased but some may be classified by the spread of the branches. Most people buy plants about half their mature size. These should usually be planted 1½ to 2 feet from the foundation wall and from 3 to 4 feet apart. Wider spacing is recommended for the more horizontal branching types.

Practically all shrubs that mature from 4 to 5 feet high should be set about 2 feet from a wall and about 4 feet apart, while those that grow from 6 to 8 feet high are planted 3 feet from a wall and 5 feet apart. A few plants in each of these size groups are distinctly upright in growth. These should be set about 6 inches closer to a wall and 1 foot closer together while the wider spreading ones should be set about 6 inches farther from the wall and 1 foot farther apart. Still larger shrubs, those that grow from 8 to 15 feet high, should be set from 4 to 5 feet from the wall and 6 to 8 feet apart. The 4- to 5-foot shrubs and the 5- to 6-foot shrubs usually are purchased about one-half mature size while those that grow from 8 to 15 feet high might be purchased somewhat less than one-half their mature size.

Small trees that mature 15 to 30 feet high may be purchased from 5 to 10 feet high, depending upon the desire for an immediate effect. For normal-shaped plants they should be spaced from 10 to 15 feet apart.

Large-growing shade trees should be of good size when they are planted as it is not worth while planting a little whip 2 or 3 feet high. Trees 1½ to 2 inches in diameter and 10 to 15 feet high, are good sizes to plant; those 4 to 6 inches in diameter will give a fair amount of shade the first season and will not be excessively expensive. Larger trees are available at a cost proportional to their size. However, shade trees are not a part of this story. Spring or fall, when the plants are dormant, is the usual planting season for shrubs. This seasonal planting is still done by most gardeners but the nursery business has progressed and modernized, following research done by the industry and at plant experiment stations. Nurseries now grow plants in a variety of containers from tin cans to heavy paper pots. The plants are kept in a thrifty growing condition the year around and it is not unusual for a home owner to buy a plant in full leaf and in flower, take it home and plant it. Such plants may require some extra care after planting, such as extra watering, but there is satisfaction in seeing them show their full landscape potential at once.

Part V — Permanent Plants for the Landscape

SELECTED ORNAMENTAL BROADLEAF EVERGREENS

Kenneth W. Reisch and L. C. Chadwick

A WIDE selection of broadleaf evergreens is available for landscape use. This group of plants offers the attractiveness of year-round foliage with the added color of flowers and fruit on many types. These evergreens are a valuable asset in any landscape planting.

Some selected types in various size groups are given here. Most of them are hardy in all except severe winter climates. Using several types and sizes adds interest to the landscape.

Vines

bigleaf wintercreeper euonymus	*Euonymus fortunei vegetus*
English ivy (selected hardy types)	*Hedera helix*

Ground Covers

wintercreeper euonymus	*Euonymus fortunei*
Japanese pachysandra	*Pachysandra terminalis*
Bowles common periwinkle	*Vinca minor* 'Bowles'

Dwarf Types—1-4 feet

glossy wintercreeper euonymus	*Euonymus fortunei* 'Glossy'
convexleaf Japanese holly	*Ilex crenata* 'Convexleaf'
Hetz Japanese holly	*Ilex crenata* 'Hetz'
Stokes Japanese holly	*Ilex crenata* 'Stokes'
Zabel laurel-cherry	*Prunus laurocerasus* 'Zabel'
Cunningham rhododendron	*Rhododendron cunninghami*

Small Types—4-6 feet

wintergreen barberry	*Berberis julianae*
Willow common box	*Buxus sempervirens* 'Willow'
Green Island Japanese holly	*Ilex crenata* 'Green Island'
roundleaf Japanese holly	*Ilex crenata* 'Roundleaf'
mountain-laurel	*Kalmia latifolia*
drooping leucothoe	*Leucothoe catesbaei*
Oregon grape	*Mahonia aquifolium*
Japanese pieris	*Pieris japonica*
Catawba rhododendron (selected varieties)	*Rhododendron catawbiense*

Medium Types—6-10 feet

hardy willowleaf cotoneaster	*Cotoneaster salicifolia floccosa*
Laland firethorn	*Pyracantha coccinea* 'Laland'
leatherleaf viburnum	*Viburnum rhytidophyllum*

Culture of Broadleaf Evergreens

Some points to consider when using broadleaf evergreens:

1. Select hardy plants.
2. Plant in well-drained soil with an ample supply of organic matter.
3. Partial shade and mulches are helpful to many species. Mulches reduce cultivation needs and help prevent damage to shallow roots of many broadleaf evergreens, such as rhododendrons.
4. Do not plant shallow-rooted evergreens under severe conditions of exposure to drying winds and winter sun.
5. Provide acid soil conditions for acid soil types, such as mountain-laurel. Equal parts of sulfur and aluminum sulfate can be used to acidify soils. 1.5 to 4 pounds per 100 square feet is usually sufficient. Recent information indicates that a reduction in the calcium level of the soil may be as important as a low pH for growing acid-soil plants.
6. Water broadleaf evergreens in the fall. Do not let them dry severely in winter. Maintain fertility.

Large Types—10-25 feet

English holly (selected hardy types)	*Ilex aquifolium*
American holly (selected varieties)	*Ilex opaca*

Rhododendrons, leucothoe and mountain-laurel fill this corner with green foliage all year

Lewis

SELECTED EVERGREENS FOR EVERY PURPOSE

L. C. Chadwick

THE narrowleaf evergreens offer many advantages for year-round effect in the landscape. Proper selection of desirable evergreens, in combination with the right deciduous plants, provide the flower, fruit, branching, foliage color and textural variations necessary for a good landscape planting. Attention to the use of the proper plant in the selected location will give the desired effect and long satisfaction.

The following selected plants are recommended. These are only some of the better types of the many available which can be used in the situations indicated (see special list for selected yews).

Narrowleaf Evergreens

Low Ground Covers

Sargent Chinese juniper	*Juniperus chinensis* 'Sargent'
Bar Harbor creeping juniper	*J. horizontalis* 'Bar Harbor'
Andorra creeping juniper	*J. horizontalis plumosa*
Japgarden juniper	*J. procumbens*

Dwarf Types (1½-4 feet)

Armstrong Chinese juniper	*Juniperus chinensis* 'Armstrong'
Andorra creeping juniper	*J. horizontalis plumosa*
Mugho Swiss mountain pine	*Pinus mugo mughus* (selected)
Woodward eastern arborvitae	*Thuja occidentalis* 'Woodward'

Top-of-steps planting is a Mugho pine set in front of the end of a clipped yew hedge

Molly Adams

The yew, *Taxus brevifolia*, makes an interesting pattern when grown against a wall

McFarland

Small Types (4-6 feet)

Pfitzer Chinese juniper	*Juniperus chinensis* 'Pfitzer'
Densiformis Anglojap yew	*Taxus media* 'Densiformis'

Medium Types (6-10 feet)

slender Hinoki falsecypress	*Chamaecyparis obtusa gracilis*
Darkgreen giant arborvitae	*Thuja plicata* 'Darkgreen'

Large Types (10-25 feet)

Keteleer Chinese juniper	*Juniperus chinensis* 'Keteleer'
Canaert eastern red cedar	*J. virginiana* 'Canaert'
pyramidal eastern arborvitae	*Thuja occidentalis fastigiata*
giant arborvitae	*T. plicata*

Trees (25 feet and over)

1. **Medium to large**

White fir	*Abies concolor*
Nordmann fir	*A. nordmanniana*
Serbian spruce	*Picea omorika*
Oriental spruce	*P. orientalis*
Limber pine	*Pinus flexilis*
Korean pine	*P. koraiensis*
Red pine	*P. resinosa*
White pine	*P. strobus*
Douglas-fir	*Pseudotsuga taxifolia*
Canada hemlock	*Tsuga canadensis*

2. **Small to Medium Trees** (25 feet or more only with considerable age)

Veitch fir	*Abies veitchi*
Moerheim Colorado spruce	*Picea pungens* 'Moerheim'
Swiss stone pine	*Pinus cembra*
Scotch pine	*P. sylvestris*

The Best of the Yews

IT is exceedingly difficult to select a limited number of the Taxus clones and designate them as "the best." The following list is my choice at the present time. Undoubtedly some additions and deletions will be made in the future.

I. Low Types, 1-4 feet

1. *Dwarf, Spreading Types*

spreading English yew	*Taxus baccata repandens*
Michell English yew	*baccata michelli*
Chadwick Anglojap yew	*media* 'Chadwick'

2. *Slow-growing, Compact, Rounded Types*

cushion Japanese yew	*T. cuspidata densa*
Flemer Anglojap yew	*media* 'Flemer'
Hill Anglojap yew	*media* 'Hill'

3. *Slow-growing, Horizontal Spreading Types*

dwarf Japanese yew	*T. cuspidata nana*
prostrate Japanese yew	*cuspidata prostrata*
Ward Anglojap yew	*media* 'Ward'

II. Small Types, 4-6 feet

1. *Slow-growing, Compact, Rounded or Globose Types*

Densiformis Anglojap yew	*T. cuspidata* 'Densiformis'
Brown Anglojap yew	*media* 'Brown'
Halloran Anglojap yew	*media* 'Halloran'
Vermeulen Anglojap yew	*media* 'Vermeulen'

2. *Slow-growing, Spreading Types*

Amherst Anglojap yew	*T. media* 'Amherst'
Sebian Anglojap yew	*media* 'Sebian'

III. Medium Types, 6-10 feet

1. *Compact, Rounded or Globose Types*

spreading English yew	*T. baccata expansa*
brevicate Anglojap yew	*media brevicata*
Dutweiler Anglojap yew	*media* 'Dutweiler'

2. *Horizontal Spreading Types*

Thayer Anglojap yew	*T. cuspidata* 'Thayer'
Hunnewell yew	*hunnewelliana*

3. *Narrow, Upright Types*

Costich Anglojap yew	*T. media* 'Costich'
Hicks Anglojap yew	*media* 'Hicks'
Moon Anglojap yew	*media* 'Moon'
Stoveken Anglojap yew	*media* 'Stoveken'

4. *Broad Fastigiate, Columnar, or Pyramidal Types*

Andorra Anglojap yew	*T. media* 'Andorra'
Cole Anglojap yew	*media* 'Cole'
Hatfield Anglojap yew	*media* 'Hatfield'
Kelsey Anglojap yew	*media* 'Kelsey'

IV. Upright Tree Types, 10-25 feet

upright Japanese yew	*T. cuspidata capitata*
Adams Anglojap yew	*media* 'Adams'

Foundation Plantings

dwarf Japanese yew
Pfitzer juniper

Hedges

Hatfield yew
hemlock

Accent Plants

hemlock
upright Japanese yew
Browns yew
Hicks yew
Canaert juniper

Screen Plantings

Douglas-fir
red pine
hemlock
junipers
Dundee and
Canaert

TREES AND SHRUBS FOR SPECIAL USES

A selected list of deciduous ornamental woody plants, classified according to the conditions under which they are most useful and the places in which they are most suitable

HOMEOWNERS and landscape gardeners should be more cognizant of the advisability of eliminating from their plantings many inferior types of deciduous and evergreen plants. It is far better to replace old, overgrown, unattractive shrubs and evergreens than to try to revitalize them by extensive pruning. Severe pruning may be practiced, but from one to three years or more will elapse before some plants become really effective again in the landscape picture. Many excellent plants are now available for landscape planting. The old overgrown ones should be replaced with some of these better shrubs and trees.

The following plants are recommended. Modifications and substitutions may be made as new and better plants become available in the nurseries, or where regional requirements demand the use of hardier or more adaptable types.

Foundation Planting

BELOW MEDIUM-HIGH PORCHES OR WINDOWS—4 TO 5 FEET

glossy abelia (*Abelia grandiflora*)
torch azalea (*Rhododendron obtusum kaempferi*)
Chinese azalea (*Rhododendron molle*)
Mentor barberry (*Berberis mentorensis*)
cranberry cotoneaster (*Cotoneaster apiculata*)
dwarf winged euonymus (*Euonymus alatus compactus*)
oak-leaf hydrangea (*Hydrangea quercifolia*)
mountain currant (*Ribes alpinum*)
garland spirea (*Spiraea arguta*)
Korean spice viburnum, or fragrant viburnum (*Viburnum carlesi*)
linden viburnum (*Viburnum dilatatum*)

BELOW LOW PORCHES OR WINDOWS—3 FEET OR LESS

Double Pink flowering almond (*Prunus glandulosa* 'Double Pink')
Crimson Pygmy Japanese barberry (*Berberis thunbergi* 'Crimson Pygmy')
creeping cotoneaster (*Cotoneaster adpressa*)
flowering quince (*Chaenomeles superba*)
Henry St. Johnswort (*Hypericum patulum henryi*)
tree peony (*Paeonia suffruticosa*)
Gold Drop bush cinquefoil (*Potentilla fruticosa* 'Gold Drop')

Border Planting

SCREEN PLANTING—10 TO 25 FEET—TOLERATING CITY CONDITIONS

cornelian-cherry (*Cornus mas*)
Washington thorn (*Crataegus phaenopyrum*)
common privet (*Ligustrum vulgare*)
Lutece Henry lilac (*Syringa henryi* 'Lutece')
wayfaring-tree (*Viburnum lantana*)
blackhaw viburnum (*Viburnum prunifolium*)

SCREEN PLANTING, HIGH HEDGES—SHEARED OR UNSHEARED—6 TO 10 FEET

Tall Hedge glossy buckthorn (*Rhamnus frangula* 'Tall Hedge')
common flowering quince (*Chaenomeles lagenaria*)
winter honeysuckle (*Lonicera fragrantissima*)

Chinese lilac (*Syringa chinensis*)
Canby viburnum (*Viburnum pubescens canbyi*)
doublefile viburnum (*Viburnum tomentosum*)

Hedges—Low, Mostly Sheared—2 Feet or Less If Sheared

Mentor barberry (*Berberis mentorensis*)
flowering quince (*Chaenomeles superba*)
dwarf winged euonymus (*Euonymus alatus compactus*)
Regel's privet (*Ligustrum obtusifolium regelianum*)
Ibolium privet (*Ligustrum ibolium*) — over 10 feet if unsheared
mountain currant (*Ribes alpinum*)
dwarf European cranberry-bush (*Viburnum opulus nanum*)—sheared or not

Shrubs and Small Trees Tolerating City Conditions

(In addition to those listed under "Border Planting")

cranberry cotoneaster (*Cotoneaster apiculata*)
showy golden-bells (*Forsythia intermedia spectabilis*)
upright European hornbeam (*Carpinus betulus* 'Pyramid')
Lavalle hawthorn (*Crataegus lavallei*)
crab apples (*Malus*) Asiatic species
common lilac (*Syringa vulgaris*)
Japanese snowball (*Viburnum tomentosum sterile*)

Trees Tolerating City Conditions

Norway maple (*Acer platanoides*)
maidenhair-tree (*Ginkgo biloba*)
thornless honey-locust (*Gleditsia triacanthos*) selected varieties
Amur cork-tree (*Phellodendron amurense*)
London plane-tree (*Platanus acerifolia*)
red oak (*Quercus borealis maxima*)
shingle oak (*Quercus imbricaria*)
Japanese pagoda-tree (*Sophora japonica*)
English elm (*Ulmus procera*)
Japanese zelkova (*Zelkova serrata*)

Shrubs Tolerating Shade and Dry Soil

fiveleaf aralia (*Acanthopanax sieboldianus*)
gray dogwood (*Cornus racemosa*)
mountain ninebark (*Physocarpus monogynus*)
Dahurian buckthorn (*Rhamnus davurica*)
jetbead (*Rhodotypos kerrioides*)
mountain currant (*Ribes alpinum*)

Shrubs Tolerating Shade and Normal Soil Conditions

(In addition to the preceding and the following group)

glossy abelia (*Abelia grandiflora*)
service-berry or shadbush (*Amelanchier laevis*)
pagoda dogwood (*Cornus alternifolia*)
cornelian-cherry (*Cornus mas*)
winged euonymus (*Euonymus alatus*)
European euonymus (*E. europaeus*)
vernal witch-hazel (*Hamamelis vernalis*)
common witch-hazel (*H. virginiana*)
Regel's privet (*Ligustrum obtusifolium regelianum*)
Ibolium privet (*L. ibolium*)
common privet (*L. vulgare*)
winter honeysuckle (*Lonicera fragrantissima*)
glossy buckthorn (*Rhamnus frangula*)
wayfaring-tree (*Viburnum lantana*)
black-haw (*Viburnum prunifolium*)
doublefile viburnum (*V. tomentosum*)
cranberry-bush (*V. trilobum*)
Canby viburnum (*V. pubescens canbyi*)

Shrubs Tolerating Shade and Wet Soil

bottlebrush buckeye (*Aesculus parviflora*)
sweet pepperbush or summer sweet (*Clethra alnifolia*)
Siberian dogwood (*Cornus alba sibirica*)
spice-bush (*Lindera benzoin*)
winterberry (*Ilex verticillata*)
withe-rod (*Viburnum cassinoides*)

Shrubs Tolerating Wet Soil But Not Shade

hazel alder (*Alnus rugosa*)
red chokeberry (*Aronia arbutifolia*)
strawberry-bush (*Euonymus americanus*)

sweet-bay (*Magnolia virginiana*)
purple osier (*Salix purpurea*)

Shrubs Tolerating Sandy Soils

Siebold aralia (*Acanthopanax sieboldianus*)
Japanese quince (*Chaenomeles lagenaria*)
sweet-fern (*Comptonia peregrina*)
cornelian-cherry (*Cornus mas*)
gray dogwood (*C. racemosa*)
blood-twig dogwood (*C. sanguinea*)
southern bush-honeysuckle (*Diervilla sessilifolia*)
shrubby St. Johnswort (*Hypericum prolificum*)
common privet (*Ligustrum vulgare*)
bayberry (*Myrica pensylvanica*)
shrubby cinquefoil (*Potentilla fruticosa*)
glossy buckthorn (*Rhamnus frangula*)
fragrant sumac (*Rhus aromatica*)
arrow-wood (*Viburnum dentatum*)

Gottscho-Schleisner

An old apple tree shades the front door; evergreens are grouped on either side

Spreading Plants to Cover Banks and Rough Places

Siebold aralia (*Acanthopanax sieboldianus*)
fiveleaf akebia (*Akebia quinata*)
American bittersweet (*Celastrus scandens*)
Siberian dogwood (*Cornus alba sibirica*)
weeping golden-bells (*Forsythia suspensa*)
Hall's Japanese honeysuckle (*Lonicera japonica halliana*)
bayberry (*Myrica pensylvanica*)
Virginia creeper (*Parthenocissus quinquefolia*)
shrubby cinquefoil (*Potentilla fruticosa*)
Alpine currant (*Ribes alpinum*)
fragrant sumac (*Rhus aromatica*)
Indian-currant (*Symphoricarpos orbiculatus*)

Small-leaved Japanese holly, underplanted with periwinkle, borders the porch which, in turn, is framed with taller holly specimens on either side. Clematis covers the trellis at right

Molly Adams

SELECTING THE BEST AZALEAS

Frederic P. Lee

THE home gardener should realize that azaleas are available in 3000-odd varieties and some are suited for each of several climatic zones over a wide area in this country. The area within which azaleas may be grown extends from New England to northern Florida and west to central Ohio and Kentucky, the South from the East coast to central Texas, and the Pacific Coast. These are forested, or originally forested, areas generally with acid (not alkaline or close to neutral) soils where native azaleas grow naturally. Useful forest humus and litter is at hand where farms and bulldozers have not destroyed or buried it. Endotrophic mycorrhizae, soil fungi associated with the nutritional processes of ericaceous plants like azaleas, and probably necessary to them, are present. Also there is an average rainfall of over 30 inches, usually 40 to 80 inches.

From these considerations can be deduced the basic requirements for azaleas: filtered shade from deciduous trees trimmed high, or full sun only in morning or afternoon; soil that is loose, crumbly, and has large amounts of organic matter or humus; a moderately acid soil; a moderately moist climate with 30, preferably 40 or more, inches of rain a year, and a constant year-round mulch.

One group is the **deciduous azaleas** that lose their leaves in the fall. These include our native species, *Rhododendron molle* and *japonicum* from China and Japan, and *flavum* from the Caucasus-Black Sea region, and hybrids of these, as the Mollis, Ghent and Knap Hill hybirds including the Knap Hill, Exbury, and Slocock strains of the last named. Various of these deciduous species and varieties are suitable where winter *average annual* low temperatures are from 10° above to 20° F. below zero. South of Pennsylvania on the eastern coastal plain, summer heat becomes increasingly a limiting factor for growing the deciduous azaleas. A race of these good for the South is yet to be developed and introduced.

The second group is the **evergreen azaleas.** Actually they are only partially evergreen since their thinner, lighter, larger, and usually more scattered "spring" leaves drop off in the fall, while their thicker, darker, smaller "summer" leaves, crowded at the tips of branches, remain over winter in most instances. The evergreen azalea species come mostly from Japan and the eastern part of Asia. Their hybrids include the Belgian Indian, Southern Indian (Indicas), Kurume, Yerkes-Pryor, Merritt, Kaempferi (Malvatica), Satsuki (Macrantha and Chugai), Pericat, Gable, Glenn Dale, and other groups. Various of these species and hybrids are suitable where winter *average annual* low temperatures are from 25° above to 5° below zero. According to the new Hardiness Zone Map being published by the United States National Arboretum in Washington, D. C., New Bedford, Mass., New London, Conn., Staten Island, N. Y., Plainfield, N. J., Wilmington, Del., Gettysburg, Pa., Baltimore, Md., Washington, D. C., and Charlottesville, Va., are typical East coast cities with average annual lows somewhere between 5° above and 5° below zero; few West coast cities reach this low an annual average.

As a guide to selection of varieties for hardiness, average annual lows for several groups of azaleas are listed below. Do not grow them in areas colder than the minimum indicated.

20° below: Ghent and Knap Hill Hy-

brids and the species *arborescens, nudiflorum, canadense, roseum, vaseyi,* and *viscosum.* Some Ghents and *canadense, nudiflorum* and *roseum* will endure 30° below.

10° below: Mollis Hybrids and the species *bakeri, calendulaceum, atlanticum, poukhanense,* and *schlippenbachi.*

0° or 5° below: Arnoldiana, Gable, Kaempferi, and Vuyk Hybrids, and the species *kaempferi* and *obtusum* var. *amoenum.*

5° above or zero: Kurume, Glenn Dale, Yerkes-Pryor, Merritt, Pericat, and Satsuki Hybrids, and the species *canescens, macrosepalum, mucronatum, obtusum, phoeniceum* f. *maxwelli, prunifolium, serrulatum,* and *speciosum.*

15° above: Southern Indian Hybrids (Indicas) and the species *scabrum* (*sublanceolatum*).

25° above: Belgian Indian and Rutherford Hybrids.

There is a great lack of familiarity with the range of plants available—a blooming range from mid-April to mid-June with a few natives blooming much later, plants dwarf to tall, and flower colors white, yellow, orange, and scarlet among the deciduous, and white, scarlet, crimson, and purple among the evergreen, including pastel tints and sparkling shades. There are striped, flecked, or sectored color designs, as well as self-colored flowers with or without conspicuously contrasting throats or eyes; also singles, semi-doubles, and doubles, any of which may, in addition, be hose-in-hose, that is, with sepals like petals.

Recommendations, with some of the less usual characteristics noted in case of the evergreens, are:

I. Deciduous

Calendulaceum (Flame Azalea): tall, select for colors orange to red.

Prunifolium (Plumleaf A.): tall, select for colors orange to red, very late.

Canescens (Florida Pinxter A.): tall, select for colors near white to deep pink; particularly for South.

Roseum (Roseshell A.): medium height, select good deep pink.

Arborescens (Sweet A.): tall, white, late, very fragrant.

Schlippenbachi (Royal A.): tall and spreading, select good deep pink form with 3- or 4-inch flowers.

Vaseyi (Pinkshell A.): tall, good pink.

White

Ballerina (Exbury)
Crinoline (Exbury)
Silver Slipper (Exbury)
Persil (Slocock)

Yellow

Adriaan Koster (Mollis)
Directeur Moerlands (Mollis)
George Reynolds (Exbury)
Golden Sunset (Exbury)
Harvest Moon (Knap Hill)
Marion Merriman (Knap Hill)
Nancy Waterer (Ghent)

Orange and Orange-Red

Coccinea Speciosa (Ghent)
Frills (Exbury)
Gallipoli (Exbury)
Golden Eagle (Knap Hill)
Goldeneye (Knap Hill)
Koster's Brilliant Red (Mollis)
Pallas (Ghent)
Spek's Brilliant (Mollis)

Red

Dr. Jacobi (Mollis)
Sang de Gentbrugge (Ghent)
Satan (Slocock)
Willem Hardijzer (Mollis)

Pink, Apricot, and Salmon

Babeuff (Mollis)
Bouquet de Flore (Ghent)
Berry Rose (Exbury)
Cecile (Exbury)
Exquisita (Occidentale)
Fanny (Ghent)
Frans van der Bom (Mollis)
Sylphides (Knap Hill).

II. Evergreens

White

Angela Place (Glenn Dale): low, late midseason.
Cygnet (Glenn Dale): low, early.
Dimity (Glenn Dale): early midseason, striped red.
Driven Snow (Glenn Dale): low, late.
Fujinishiki (Satsuki): frilled, late.
Glacier (Glenn Dale): late midseason.
Gunbi (Satsuki): low, very late, red stripes, frilled.
Helen Close (Glenn Dale): late midseason.
Jindai (Satsuki): very late.
Kow-Koku (Satsuki): low very late.
Kure-No-Yuki (Kurume): semi-double early.
Magnifica: conspicuous blotch, *mucrona-tum* form, early midseason.
Mucronatum (Indica Alba): species, early midseason.
Safrano (Glenn Dale): late, low.
Treasure (Glenn Dale): late midseason
White Gumpo: *eriocarpum* form, very low, very late.
White Perfection (Yerkes-Pryor): hose-in-hose, early midseason.

Orange-Red (scarlet)

Amber Glow (Bobbink & Atkins Macrantha Hy.): late midseason, hose-in-hose.
Ballet Girl (Glenn Dale): early.
Balsaminaeflora: *indicum* form, low, very late.
Beni-Kirishima: *indicum* form, late.
Bunkwa (Satsuki): very late, low, white with orange-red margin.
Copperman (Glenn Dale): late.
Dr. E. A. Merritt (syn. China, Chisolm-Merritt): early midseason.
Flander's Field (Pericat): late midseason.
J. T. Lovett: *indicum* form, late.
Kagaribi (Kurume): early midseason.
Keisetsu (Satsuki): late, white throat.
Kintaiyo (Wada Seabrume): white edged bright orange, early midseason.
Picador (Glenn Dale): early midseason
Sakuragata: *indicum* form, white throat late.
Snetsumu (syn. Flame, Kurume): early midseason.
Tama-sugata (Satsuki): very late, white throat.
Tanager (Glenn Dale): late midseason

Red (crimson)

Aztec (Glenn Dale): low, very late, white throat.
Chippewa (Bobbink & Atkins Macrantha Hys.): very late, frilled.
Dayspring (Glenn Dale): early white with pale rose margins.
Fortune (Pericat): semi-double, early midseason.
Gunrei (Satsuki): low, very late, flushed red, frilled.
Hexe: low, late midseason, hose-in-hose, frilled.
Kingetsu (Satsuki): low, very late, white throat.
Mai-Hime (Satsuki): low, very late, self red and red flushed, striped, and flecked on white.
Peach Blow (Kurume): flushed red, early midseason.
Pearl Bradford (Glenn Dale): low, very late.
Shinnyo-No-Tsuki (Satsuki): low, very late, white throat, tender.

Shin-utena (syn. Santoi, Kurume): white tipped violet-red.

Splendor (Pericat): semi-double, hose-in-hose.

Spring Glory (Pericat): hose-in-hose, frilled.

Sweet Briar (Kurume): flushed red, early midseason.

Warai-Gishi: *indicum* form, late.

Wildfire (Glenn Dale): low, late, white throat.

Yaeshojo (Kurume): early, hose-in-hose.

iolet-Red (pink)

Azuma-kagami (syn. Pink Pearl, Kurume): hose-in-hose.

Bridesmaid (Kurume): early midseason.

aress (Glenn Dale): early, lighter throat.

rinoline (Glenn Dale): late midseason.

rusader (Glenn Dale): late, low.

Dawn (Pericat): white center, hose-in-hose, late midseason.

Dream (Glenn Dale): early.

uy Yerkes (Yerkes-Pryor): hose-in-hose, early midseason.

latsushimo (Kurume): flushed violet-red, white edging, conspicuous blotch, early midseason.

Ho-oden (Kurume): early mid-season, white edges, blotch, hose-in-hose, low.

Joya (Glenn Dale): early midseason.

Martha Hitchcock (Glenn Dale): early midseason, white throat.

Maxwelli: *phoeniceum* form.

Mayo's Magic Lily (Mayo): flushed violet-red, late midseason.

Pink Profusion (Yerkes-Pryor): hose-in-hose, early midseason.

Sagittarius (Glenn Dale): low, very late.

Sensation (Pericat): low, late midseason, hose-in-hose.

Stunner (Glenn Dale): low, very late.

eddish Violet (lavender and purple)

Anne Chenee (Pericat): white flushed purple, hose-in-hose, frilled.

hanticleer (Glenn Dale): late.

Dauntless (Glenn Dale): low, late, throat scarlet.

ibiyama (Kurume): early midseason.

Hazel Dawson (Dawson): late midseason.

ilacina: *mucronatum* form, early midseason.

Padre (Glenn Dale): early midseason.

Sarabande (Glenn Dale): late, white throat.

Usuyo (Kurume): early midseason.

Yo-zakura (Kurume): early midseason.

Zulu (Glenn Dale): late midseason

The following evergreen azaleas are in general a little hardier than those listed bove:

Vhite: Palestrina (Vuyk); Rose Greeley (Gable).

range-Red (scarlet): *kaempferi,* species; Mary Dalton (Gable).

ed (crimson): John Cairns (Kaempferi); Othello (Kaempferi); Stewartsonian (Gable); Vuyk's Scarlet (Vuyk).

Violet-Red (pink): Carol (Gable); Chopin (Vuyk); Fedora (Kaempferi); Jessie Coover (Gable); Kathleen (Kaempferi); Springtime (Gable).

Reddish Violet (lavender and purple): Big Joe (Gable); Gretchen (Kaempferi); Herbert (Gable); Purple Splendour (Gable); Purple Triumph (Vuyk); Viola (Gable); *poukhanense,* species.

For every variety recommended above, there are usually a half dozen other varieties that could be substituted as similar and equally good.

For warmer areas, where the temperature does not go lower than 15° above zero in case of the Southern Indian Hybrids (Indicas) or 25° above zero in case of the Belgian Indian and Rutherford Hybrids, varieties from these groups are commonly used. They have on the whole both the largest and the finest flowers of all the evergreen azaleas.

Recent Developments

A few of the Satsukis, known here as Macrantha Hybrids or forms, are available. A few others from the Chugai Nursery in Japan, sometimes called Chugais, were brought in by the Plant Introduction Section, United States Department of Agriculture. Both of these are of great interest because of their late bloom, low growth, and beautiful flowers, frequently of several different color designs on the same plant. A dwarf race of Kurumes is also on the way from the Department of Agriculture. Among the newer evergreen groups are the Glenn Dales. Plants cover about five different blooming periods from mid-April to mid-June, with dwarfs to talls and a great array of colors and flower designs for each period. Some Gable Hybrids, another recent group, average perhaps a little hardier than the average Glenn Dale or Kurume. Still to be introduced are the Hirado Hybrids from Japan, a few of which have been brought in recently by the Plant Introduction Section, many more of the Satsukis recommended by the Japanese Satsuki Society, and about 25 or 30 little-known eastern Asian species.

In the deciduous azaleas, new Knap Hills are being introduced each year in too great numbers, but among them are many lovely flowers.

With so many azaleas to choose from, it is a bit dull and routine for home owners to choose over and over the same half dozen azalea varieties carried by the run-of-the-mill nurseries. Women do not all select the same half dozen hats. See what the specialist nurserymen have to offer in newer and different azaleas, usually at the same or lower prices.

Evergreen Kurume azaleas make bushy, spreading plants which are solid masses of color in brilliant or pastel tones

Azalea schlippenbachi is deciduous, upright growing, and its large blossoms are a delicate tone of pink

Roche

HELPS TO EFFICIENCY

Alys Sutcliffe

Advice to beginners on sources of information and ways of avoiding a few common pitfalls

MANY a would-be gardener is at a loss to know how to get the information and the supplies that he needs. He does not know where to learn about gardening, either directly or through books; or where to buy plants, seeds, fertilizers, sprays, and tools.

He is often carried away by advertisements offering cheap plants of unknown origin; innumerable novel appliances, or gadgets, guaranteed to take all the work out of gardening, and sprays and weed killers guaranteed to make the garden grow and weeds disappear without any effort on anybody's part—least of all the gardener himself. A person thus misled finds himself, in the end, surrounded by dead and dying plants, enough bottles to stock a drug store, and enough tools to supply the neighborhood—without the remotest idea what to do with them himself.

Information

Short courses are given in many towns and cities by garden clubs, botanic gardens, horticultural societies, arboretums, community centers, and schools. They can be very helpful, since they offer practical instruction and often an opportunity to work with materials yourself.

Questions sent to garden editors of papers and magazines are always answered. Botanic gardens generally give information by letter and by telephone. County extension agents also are available by phone or letter, too.

Libraries of botanic gardens and horticultural societies have good collections of books on gardening for beginning and experienced gardeners. Public libraries, at least in the larger towns, have the important garden encyclopedias and the more popular garden books. The gardener can see these books and decide which ones would be most useful for him to own.

If books seem too complicated for beginners, there are several garden magazines available which give timely information on what to do in the garden, and also include newsworthy garden information. Most of these magazines are on file in public, botanic garden and horticultural libraries, or may be obtained regularly by subscription.

Many special plant societies, devoted to one group of plants such as rose, iris, daffodil, dahlia and chrysanthemum, publish their own magazines and yearbooks which are in horticultural libraries and are supplied to their members.

Plants

Catalogs are published by most of the reputable dealers. Generally these are sent free on request; and while there is a small charge for some, they are well worth it. Dealers with good reputations of long standing are safest for beginners.

In this group are firms that specialize in certain kinds of plants, such as iris, peonies, gladiolus, African violets, hemerocallis and unusual plants. These firms, among others, supply plants by mail. Most of them use new improved packing methods so that plants can be sent long distances and still arrive safely.

Visits to nurseries are a great help; these should be made when plants are in full flower or growth. (Be considerate of the nurseryman's time if you are only "looking.") By seeing plants at their best season one can choose the plants he likes and get a better idea of price in relation to size. In arboretums and botanic gardens, choice plants correctly labelled may be seen.

BROOKLYN BOTANIC GARDEN RECORD

PLANTS & GARDENS

A HANDBOOK ON BREEDING ORNAMENTAL PLANTS

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Blueberries

NEW SERIES
Vol. 15, No. 2

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PLANTS & GARDENS

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Editorial

George L. Slate, *Guest Editor*
Paul F. Frese, *Associate Editor*
and the Editorial Committee of the Brooklyn Botanic Garden

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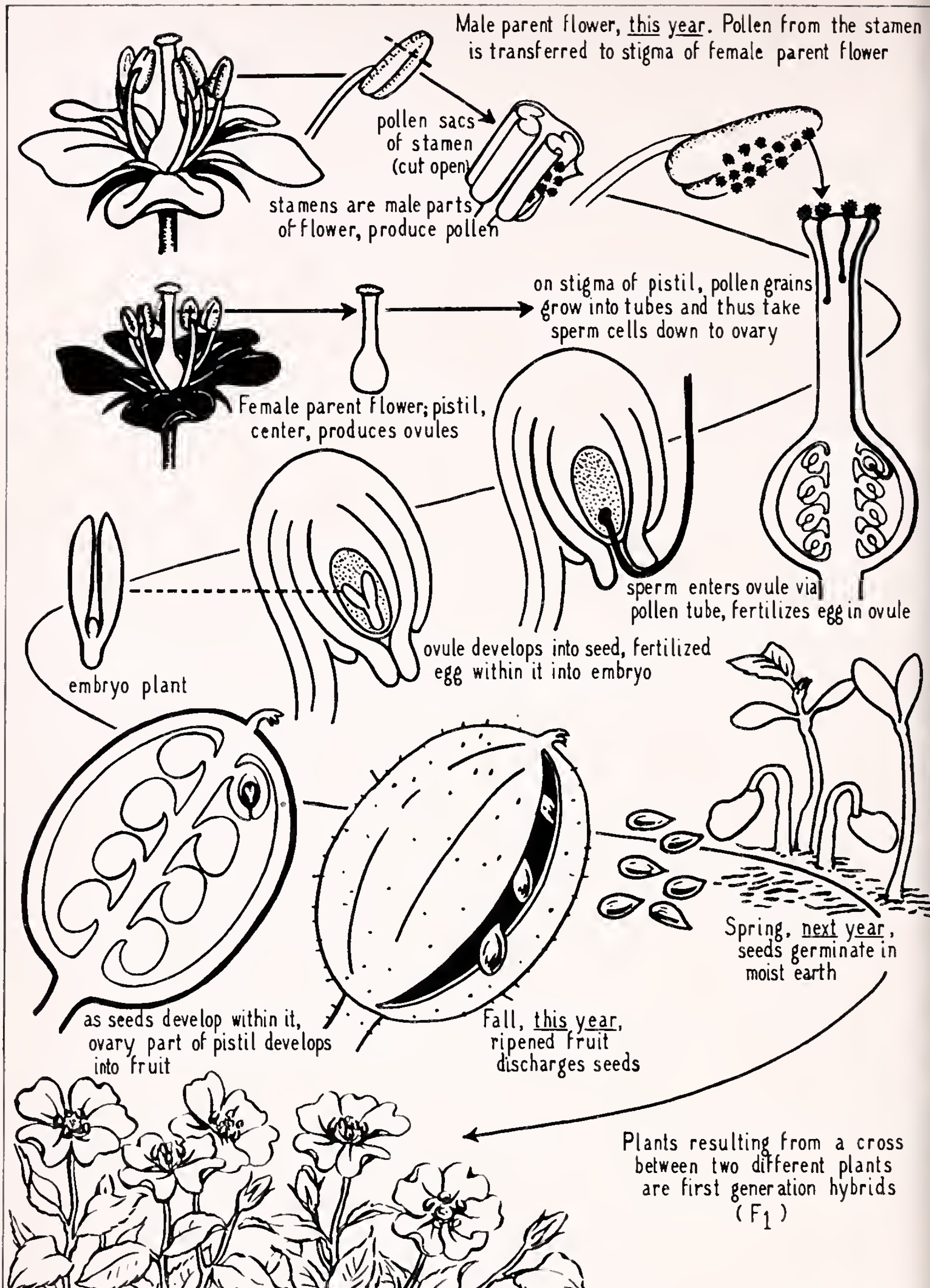

Eva Melady

Sketches to show steps and events in plant breeding. When the flowers of two different plants are cross-pollinated, seed is produced which will grow into plants that may differ from their parents. If breeding is carried on selectively, for several generations, worthwhile new varieties may be produced

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES
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One hundred years ago Charles Darwin published his "Origin of Species." He observed—as had others before him—that the plant and animal population of the earth is constantly changing, that new species are constantly being derived from older ones. He concluded that this slow but continuous change has gone on since the appearance of the first primitive living things.

Now about change among the flowering plants, whose life on earth spans only the last few million years: As bees and other insects—and even the wind—carry pollen hither and yon, there is, obviously, no planned parenthood. Out of this great mixing process and several million years to work it out, more than 200,000 kinds of wild flowering plants have become more or less stable species. They maintain their identity generation after generation. Some species may last in nature for a few thousand years, others a few million. These are the main-line facts that scientific research has given us.

Man's chief discoveries about the world he lives in have been confined to the Christian era, and more particularly to the last few centuries. For example, sex in plants was discovered about 200 years ago, and certain basic laws of inheritance a century ago (Mendel). With this knowledge, man has been able to guide and speed plant improvement, especially in the last 50 years. Agricultural plants have had the greatest attention, for understandable reasons, but the vast number of varieties of ornamental plants gives testimony to the increasingly active interest of plant breeders. To wit—thousands of man-made varieties of roses, tulips, iris, daffodils, chrysanthemums, azaleas, etc. Natural evolution has given way to guided evolution—the direction depending on the needs and whims of man.

Before the laws of inheritance were understood, new kinds of plants were simply selected from among those that happened to be discovered. For example, among the trees familiar to many gardeners and amateur horticulturists is the pink saucer magnolia *(M. soulangeana)*. It is a chance hybrid between the Yulan magnolia *(M. denudata)* and *M. liliflora*, and was noticed about 1820 in the garden of M. Soulange-Bodin, near Paris. The only plant breeder in this instance was an insect—or perhaps a puff of wind that carried the pollen from one species to the other.

Today, breeders select parent plants for certain special qualities and make their crosses with particular objectives in mind, as will be clear from a number of the articles in this Handbook. Here, shorn of its technical details, is an example of what may be learned via present-day techniques: Among the garden campanulas is *C. persicifolia*, a species that ordinarily grows to 2 or 3 feet in height. Sometimes seeds of this species give a dwarf that grows to 8 or 12 inches. The latter is so strikingly different from the parent that it is known as *Campanula nitida*—yet it is only a variety of the species *persicifolia*, and therefore does not deserve a species name; it is a simple recessive, the tall-growing habit of the parent being completely dominant in inheritance. Both forms have the diploid chromosome number 16. *Campanula persicifolia* has given rise also to a giant form, known in England as 'Telham Beauty,' which is tetraploid, its chromosome number being 32.

Most of the authors Guest Editor Slate has invited to write for this Handbook on Breeding Ornamental Plants are themselves active plant breeders and their total experience would come to hundreds of years! They know whereof they speak, and their contributions are warmly appreciated. For convenience, some authors have used technical terms. Don't be dismayed—turn to the meanings of terms in the pages at the back.

We hope above all that this Handbook, planned largely for amateurs, will open up a "whole new world" for many readers.

Sincerely yours,

George S. Avery

Director

PLANT BREEDING AS A HOBBY

The pleasure and profit to be gained—
and what it takes to get started

E. Frank Palmer

WHY have a hobby? Why plant breeding?

For me, and for many people I'm sure, that first question is easily answered. Whether we be young or old, still gainfully employed or enjoying the sunset of our years, we benefit from the absorbing interest of a worthwhile hobby. And it's never too early to start. Too often we're inclined to say to ourselves, "I'll think up a hobby, something to do, after I retire."

Worthwhile hobbies may not come that easily. What should we do when we find ourselves at loose ends, with time on our hands. We sense that the years added to our life—our twentieth-century greater life expectancy—are of doubtful value unless we can add life to those years. A hobby does just that! And if it is started relatively early in life, so much the better. It will provide a balance wheel for everyday living, and when retirement comes it will successfully cushion the transition period. In fact you may find, as I have, that you are just as busy as ever—but more relaxed.

Why plant breeding as a hobby? Take it up only if you are a gardener by inclination, a plantsman, genuinely interested in growing things. That is the one fundamental qualification, at least for the hobbyist.

You may be discouraged by the too-general feeling that plant breeding, hybridizing, is a difficult procedure, calling for knowledge and techniques not available to the average flower lover. Such, in reality, is not the case. The technique of hybridizing for most commonly grown horticultural plants, flowers, fruits, vegetables, may be learned in a few minutes by a normally observant person, given some previous, or on-the-spot, knowledg of the parts or organs of flowers.

There is no particular need to worr about genetics, although such knowledg can be useful. Generally, leave genetic to the geneticists. Their knowledge i their livelihood. You're a hobbyist, ou to enjoy yourself.

Mostly, your needs will be met by a good species and variety collection of th plant of your choice, an understandin of its cultural needs, and an awarenes of how it may be improved for man' purposes. That awareness will com gradually, as you come to know you plant better and better.

This is not to decry the value of a goo knowledge of genetics. Such knowledg can be most useful, especially if you ar breeding crops, such as most vegetables which must be seed propagated. The may require several generations of care ful selection to establish "varieties" whic will come true from seed. Or genetic may point the way to short cuts in th breeding program. But for a hobby it' best to at least start with plants whic may be vegetatively propagated. Then if in the hybrid generation you grov from seed there are promising hybrids these can be immediately propagated true-to-name, simply by division (buds cuttings, bulblets, suckers, etc.) of th original hybrid plant. Right away yo are in business.

To digress somewhat, perhaps part o the attraction of plant breeding as a hobby is that it is an art rather tha a science. The science is genetics. Thi has been clearly stated by several individ uals in recent years.

In 1952, Dr. V. R. Boswell of th Plant Industry Station, Beltsville, Mary

land, had this to say in "Economic Botany": "The most efficient practice of the art of plant breeding now depends heavily upon the principles and mechanisms of heredity that have been revealed by research in genetics, cytology and cytogenetics . . . Despite the important aid of several modern sciences, however, plant breeding is still basically an art that is hundreds of years older than those sciences . . . True enough, training, experience and a suitable scientific background can help make better plant breeders, but first of all a good plant breeder is a good plantsman."

Then, the notes which immediately follow were made from a paper given by Dr. Kenneth Mather (Department of Genetics, University of Birmingham, England) at the 1952 International Horticultural Congress, London. "Plant breeding is applied genetics but it goes beyond genetics as a science. The plant breeder may not always use genetics. The geneticist advances scientific knowledge. The plant breeder improves plants." That's us!

Just here, a further view of Dr. Mather's may be of interest. In substance he said:

> "The older view that genes could be arranged at will to produce any desired result is no longer held. Useful genes are not individuals to be handled according to Mendelian technique. Mostly they are members of a swarm of genes which, *in the aggregate,* contribute to a desirable character in the new plant. Each gene is of small importance. The use of genes is not just a laboratory exercise . . . Plants which look alike may 'breed' very differently. There is no sure means of telling, except by observed results.
>
> "Genetics, in brief, cannot give the plant breeder a detailed recipe for the results he seeks, but it can aid in various ways."

Some 20 years ago, in an article for a gladiolus annual, I wrote in part as follows:

> "By the art of breeding . . . I have in mind the guiding sense which suggests the making of certain crosses, and the ability to select out from the resultant thousands of seedlings those particular ones which have potential value, discarding all else . . . That happy ability may be natural or may be developed but . . . must have as a background an adequate knowledge of existing varieties . . . Part of the art of breeding is the ability to effectively use gradually accumulated knowledge. That knowledge can never be complete because new variety material is constantly appearing; also our ideals change with the passing years."

Too, one cannot help speculating at times by what happy chance any given seedling, later to be recognized as a worthy addition to our list of varieties, was saved for further trial, by what narrow margin it may have escaped elimination at the time of its first blooming or fruiting. How many seedlings *were* thrown away which, if saved, might have proven worthwhile? But that is part of the art of breeding—the ability to recognize potential value. Partly, as already indicated, that ability comes from a plantsman's knowledge of existing species and varieties of the plant with which he is working. Somewhere along the line unconscious mental processes take over, suggesting a certain cross; or the saving or discarding of this or that seedling.

So, you and I fundamentally are plant breeders, rather than geneticists. We can be effective plant breeders, however meager our knowledge of genetics, if we love and understand plants. We are "hobby" plant breeders, not required to make a living at it, or to advance scientific knowledge. We are doing something we like to do, with, perhaps, the hope that an origination of ours, whether flower, or fruit, or vegetable, will some day find acceptance as an "improved" variety.

Whether or not that hope becomes a reality is, perhaps, immaterial. The main objective is plant breeding as a hobby, a relaxing, outdoors occupation. As such, it will add an extra dimension to the pleasure of gardening. It will eventually

distinguish your garden in that you have become somewhat of a specialist in one or more kinds of plants, background material for your hybridizing efforts.

As an example, in my own garden are featured roses, lilies and clematis, and I'm struggling with the primula family. These are superimposed on a fairly broad collection of ornamental material—evergreens, shrubs, perennials, annuals.

In any event, whatever the material success of your plant breeding efforts, they will pay off handsomely in that you have added "life to your years." To me that means that, in some measure, you have brought yourself into harmony with your surroundings.

I have said little of the techniques of hybridizing other than to suggest that, in many cases, they can be very simple. In fact, for the first year or two, and if you are working with plants which do not come "true" from seed, you can start your breeding program with open-pollinated seeds, that is, insect-pollinated. You won't know the pollen parent of course, but you will have a variable seedling population in which there may well be something of value.

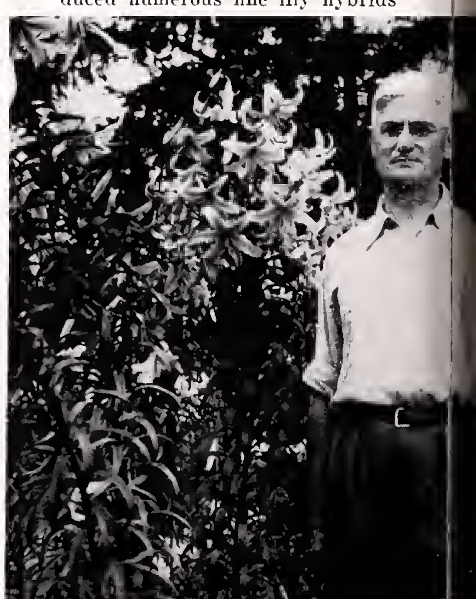
I assume that other articles in this handbook will deal with pollination, fertilization, covering of blooms, seed care, and like matters. Even so, for the hobbyist alone, and for his encouragement, I would like to make one or two observations gleaned from my own experience.

The gladiolus and the lily, as examples, need little or nothing in the way of bloom protection (bagging) following artificial pollination. My procedure, proven entirely adequate over many years, is generally as follows. Emasculate (remove the stamens with fingers or tweezers) freshly opened blooms of the intended seed parent in early morning before the anthers split, exposing their pollen. Pollinate immediately *and thoroughly* with pollen gathered the previous day from the pollen parent of the cross. No camel's hair brush is used. Simply smother the end of the stigma (female organ), whether or not receptive (indicated by surface stickiness), with pollen by touching it with a mature anther, or dipping into loose pollen kept in a salve tin or other small container. In other words, get there first with the most. And you don't mess up your garden with the unsightly bags (tied over emasculated flowers), so necessary to more "formal" breeding. Label your pollinated blossoms with marking tags tied to the stems, and pray for a good seed harvest.

Adequate records should be kept. Part of the pleasure of the hobby will be to keep such records so that you may know, as the breeding material accumulates over the years, the complete variety background of each "family" group, and each selection.

I fully appreciate that by no means all kinds of flowers can be treated so simply as the lily and the gladiolus. Study your particular flower and decide, perhaps with some expert advice, just what precautions must be taken. But avoid making the procedure any more complex than is absolutely necessary. Remember this is a hobby, to be enjoyed. You're working for yourself.

E. Frank Palmer, best known as the originator of gladiolus 'Picardy', also has produced numerous fine lily hybrids



SUGGESTIONS FOR AMATEUR PLANT BREEDERS

Desirable though not "musts" for the beginner

George L. Slate

THE records show that countless popular varieties of such plants as iris, daylilies, camellias, gladiolus and African violets were produced by amateur plant breeders. Some of these amateurs hybridize plants just for the fun of it; others are out to make money.

Many amateurs have had little or no training in plant breeding science and techniques. Whereas they have given us many good new varieties, they could have been more efficient if they had known more about breeding principles.

Selecting Plants to Hybridize

In the beginning, the prospective breeder will have to decide what plant to hybridize, whether it's an old-time favorite or some worthwhile plant that needs improvement.

Such popular garden plants as roses, gladiolus and iris have received much attention from amateur and professional breeders over the years. The present-day varieties are a great improvement over their wild ancestors. Yet, there is always room for a new breeder, and if he is thorough, hardworking and alert to opportunities that present themselves he can soon carve a niche for himself. Careful observation will soon indicate where one's efforts can be most profitably directed.

Vegetatively propagated plants are most appealing because striking new hybrids may be perpetuated easily, whereas seed plants require many generations of selection to fix the new type so that it will come true from seeds.

Anyone looking for plant groups to hybridize might check through Bailey's "Encyclopedia of Horticulture" in which various genera, their cultural requirements and the species and their variabilities are given. After a list of prospects has been compiled, refer to seed catalogues such as that of Thompson and Morgan, Ipswich, England and those of nursery specialists for seeds and plants to work with. If one is still undecided, he should consult a horticulturist or botanist with a wide knowledge of plants. Members of the special plant societies can point out opportunities within their own fields.

Information Needed by the Breeder

The more a breeder knows of the vital statistics of a variety, the better. What were its parents; were any species used to produce it? Species not generally in cultivation should be studied, if possible, because there are instances in which unusual hardiness, disease or insect resistance and attractive plant character can be obtained only by using species in a breeding program.

It is important to learn which are the best parents. Yearbooks, bulletins and magazines published by plant societies and other organizations are the first source of information. Other breeders can be helpful. As soon as one has seedlings in flower, one's own records, if well kept, will be an invaluable source of information as to the best parents. Many very good varieties are poor parents and rarely or never yield good seedlings. Other varieties may yield whole families of fine seedlings. It is impossible to determine whether a variety will make a good parent without using it in a breeding program.

The limits of crossing cannot be determined without trying. A knowledge of the chromosome relationships, while not a necessity for the beginner, may be helpful in avoiding a lot of pollination work that might not yield many seedlings. This

is especially true for groups with many species having different chromosome numbers. Triploid (having three sets of chromosomes) varieties, for example, are unlikely to be of use in a breeding program. Varieties with widely different numbers of chromosomes are not likely to cross, or if they do cross, the hybrids may be weak, die soon, or be sterile.

One need not be a cytologist to use this knowledge of chromosome numbers.

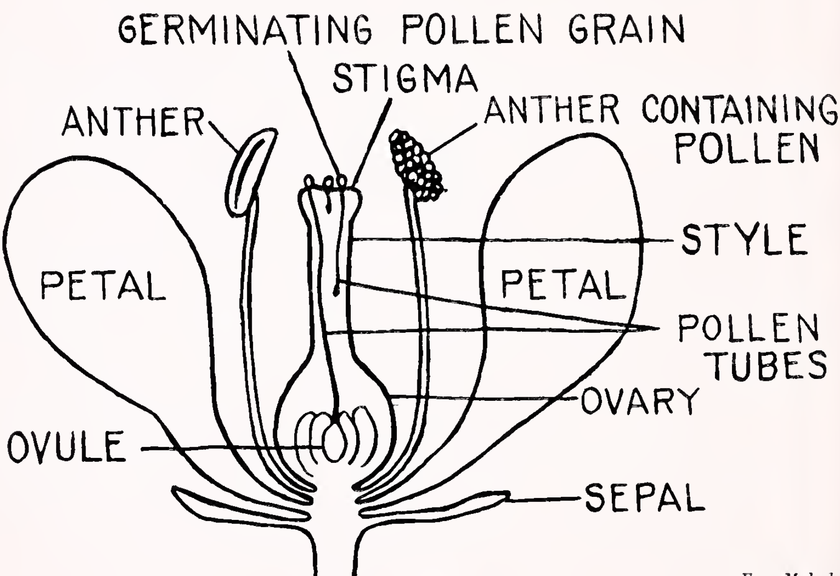
Chromosome counts are recorded in many places. The first place to look is the "Chromosome Atlas of Cultivated Plants," by Darlington and Ammal. A list of species should be made up according to the chromosome number for each species. Thus all the diploids (having two sets of chromosomes) should be in one group, all the triploids in another and so on through the genus. For some plants there are published papers in botanical libraries dealing with chromosome numbers and their significance to the breeder.

Many plants are self-incompatible, *i.e.*, do not set seed when self-pollinated. Some are cross-incompatible. Peace rose, for example, sets seed poorly but has fathered many fine new varieties. Knowledge of these incompatibilities may save one from attempting crosses that will not work.

Some plants reproduce the seed parent exactly regardless of the pollen used. One may not make much progress attempting to hybridize plants where this situation occurs.

Plants must be kept healthy and vigorous if they are to bear seed. Diseases and insects are hazards with many kinds of plants. In a breeding program, one must be prepared to cope with them. Viruses are very difficult to handle with some plants, and harmful soil organisms are hard to detect and control.

Special soil requirements should be



Eva Melady

Longitudinal section through a flower. *Pollination* of a flower occurs when *pollen grains* become fixed to the (often sticky) surface of the *stigma*. The pollen grains "germinate" and grow their way down through the *style* as *pollen tubes*. Each pollen tube carries 2 sperm cells, one of which unites with an egg when the pollen tube reaches the *ovule*. The union of sperm and egg is "fertilization." Many ovules may be borne within the *ovary* of the flower, and the fertilized ovules develop into seeds; at the same time, the ovary grows into the fruit. *Petals* are the ornamental part of the flower; *sepals* are usually leaf-like, often green

known. How much winter cold and spring frost will the plants take? How are they propagated? One must also learn how to handle the seeds for best results. Some seeds require special storage conditions for after-ripening to make them germinate quickly.

The need for all such information as follows may seem rather overwhelming to the beginner; it is acquired gradually through the years. The better one is informed about his favorite plant the more interesting it becomes.

Sources of Information

A knowledge of elementary genetics is very helpful. The article on p. 12 by S. L. Emsweller will supply all the genetic information needed at first. Although many fine varieties were developed in the past from natural variation, chance hybridizing and controlled crosses long before the rediscovery of Mendel's law, scientific plant breeding made much more rapid progress as the discoveries of the geneticist and cytologist were used by the breeders.

In a serious breeding effort involving species of plants, a taxonomic study of the genus, either in a botanical monograph or in a flora of the region where there are many species, should be consulted, and the plants grouped according to the section of the genus in which they are located. A geographical grouping is also useful. For example, one might list the iris of the eastern United States in one group, those of the western United States in another, those of the eastern Mediterranean in another and so on through the genus. A comparison of the botanical, cytological and geographic groupings might well provide some clues to new approaches for the hybridizer.

Bailey's "Encyclopedia of Horticulture," Bailey's "Manual of Cultivated Plants," and Rehder's "Manual of Cultivated Trees and Shrubs" should be consulted for botanical and geographical information.

Various plant societies publish yearbooks with much information as to varieties and breeding work with the particular flower. Several yearbooks dealing with specific flowers are published by the Royal Horticultural Society, London, England. The prospective breeder should note the parents which have given rise to superior new varieties and plan to use them in his breeding program.

One of the best publications on flower breeding is the article in the 1937 Yearbook of the United States Department of Agriculture, by Emsweller, Brierley, Lumsden and Mulford, entitled "Improvement of Flowers by Breeding." The extensive bibliography is not included in the Yearbook, but is in the Yearbook Separate No. 1591. These are out of print and will have to be consulted in libraries.

Other sources of information are Plant Breeding Abstracts (England), Journal of Heredity, and Hayes and Immer "Methods of Plant Breeding." Two very useful books are Crane and Lawrence "The Genetics of Garden Plants," and Lawrence "Practical Plant Breeding." One should browse in one of the large horticultural libraries for additional references.

To study varieties, one should attend the shows of the specialist societies, visit test gardens and private collections. Much useful information will be acquired by talking with the breeders at shows. A visit to the seedling plantings of a breeder should be very useful, too.

Collecting Breeding Material

The breeder who proposes to do a thorough job must have a fairly extensive collection of the species and varieties of the plants with which he intends to work. Plant societies often have symposia, in which they rate the varieties in each class, which may be good guides for the beginner starting to build a collection. The first and most obvious source for these plants is the nursery specializing in them.

Wild variants of some plants may be sought out and added to the collection. This is often done with lilies.

One should join the society catering to the growers of the plant in question. Foreign members often will exchange seeds and plants of their native species for similar material from one's own country.

Botanical gardens and arboretums may supply some species not otherwise available, but should not be expected to provide more than a scion, budstick, a very few cuttings, or seeds. Local botanists and plant collectors can sometimes supply plants not otherwise obtainable.

Recognized breeders who are working actively with certain plants may sometimes get material from the New Crops Research Branch, Plant Industry Station, Beltsville, Maryland.

Some breeders are generous with pollen and a gift of pollen from a valuable plant is a choice acquisition for one who knows how to use it to the best advantage. Pollen should not be taken from garden plants or from plants in flower shows without the permission of the owner or exhibitor. Those who receive pollen should expect to reciprocate with something equally choice.

Some breeders give other specialists plants of their new selections in advance of introduction for preliminary tests. The beginner must not expect these until his experience and judgment make him a worthy recipient of these plants. Moreover, unintroduced plants should be considered as the property of the breeder until released by him.

Objectives

The amateur plant breeder should have definite objectives that are reasonably sure of being attained. It is mostly a waste of effort to make unplanned crosses of whatever happens to be in bloom. Planning and the acquisition of knowledge that makes intelligent planning possible is half the fun in plant breeding.

The amateur plant breeder who is just beginning his program should limit his efforts at first, or he may be overwhelmed by it and lose his interest. The project should start off on a small scale and expand as interest, experience and resources are developed.

Plant characteristics: The beginner is inclined to be concerned mostly with flower color, form and size, but as he gains experience it will become evident that other characteristics are often more important. *Vigor* is essential in most garden plants. A vigorous plant need not necessarily grow to a larger size than its fellows, but it should grow well and be easy to maintain in the garden. *Winter hardiness* is essential and with plants that are not fully hardy progress in the direction of greater hardiness should be sought. The culture of half-hardy plants may sometimes be extended by breeding them in colder regions than where they normally grow well. *Frost resistance* is another desirable attribute of many plants. It may be sought through developing plants which have actual resistance of the tissues to low temperatures on a frosty night, delayed foliation, or delay in appearing above ground as with some lilies.

Resistance to disease may be a rather complicated and not very exciting objective for the amateur plant breeder. Some fungus diseases constantly develop new strains or "varieties" and a plant supposedly resistant to a disease may suddenly lose its resistance when a new strain of the fungus appears. Flower breeders are probably unconsciously producing varieties that are either tolerant of viruses, or do not become infected easily. This is certainly happening with some lilies and probably with other garden plants.

The amateur breeder should consult work on disease resistance, with a plant pathologist in an agricultural experiment station, botanic garden, or similar institution.

The growth habit should be attractive. Usually a moderately compact, neat, tidy upright plant that does not require staking is more attractive than a leggy or sprawling plant. The foliage should be bright and remain so for as long as possible. Foliage that becomes unsightly

prematurely, from early ageing or injury from diseases or insects, is not desirable and may be avoided by selecting the right parent.

Ease of propagation is essential in any plant that is to be distributed widely by nurseries. Plants not easily rooted from cuttings, or easily grafted, no matter how beautiful, are not likely to interest commercial nurseries, but they may be very useful in the originator's garden.

Flower characteristics: The amateur is usually most interested in breeding for better flowers. With many common garden plants, competition is very keen and hundreds of new varieties are produced each year. Many of these differ only slightly from their predecessors and soon disappear from the trade. There are very few roses equal to the variety 'Peace', or gladiolus equal to 'Picardy.'

Purity of color is very important and there are few varieties that are as good as we should like them to be in this respect. New colors are always in demand and sometimes the use of a previously neglected species may work wonders in that respect. *Increased substance* and *longer keeping quality* are highly desirable. With many flowers *increased size* is being sought, but the little fellows also have their followers.

Variety of form is an important objective and breeders are trying to produce flowers that look like those of other plants. *A pleasing fragrance* is a desirable attribute of any plant. *Early and late blooming* varieties lengthen the season for our favorite flower. *Length and stiffness of stem, the pose and the placement of the flowers* in the inflorescence are all important characteristics that must be considered in a breeding program.

How To Go At It

Most varieties of our common, vegetatively propagated garden flowers have originated through the hybridization of varieties. Variety crossing is still the principal source of new varieties. In crossing varieties, the breeder selects two parent varieties that have as many desirable characteristics as possible and crosses them, hoping that some of the resulting seedlings will have many of the desirable characteristics of both parents. Usually most of the seedlings are undesirable, but now and then a cross pays off with some good progeny. When this happens the cross should be repeated on a larger scale if the original population was small. Both parents should be used in crossing with other varieties. After several years of experience, the good parents become known and are exploited as the project develops.

Amateur breeders often fail to exploit the second generation and back crosses. Frequently when the first generation fails to yield anything of value, another generation should be raised by crossing the F_2 seedlings with each other or with their parents. The resulting seedlings may well yield some with the desired combination of characters.

The possibilities of introducing worthwhile characteristics of overlooked species into our common garden plants should be explored. Wide crosses, or crosses between plants that are not closely related, if they succeed, may produce sterile offspring. Nevertheless, they should be tried as they occasionally yield worthwhile results.

Inbreeding which has given such good results with corn and a few other plants is not likely to be of much value in breeding vegetatively-propagated plants. It takes many years; self-unfruitfulness of many varieties prevents it, and the loss in vigor of inbred lines may run the project into the ground. The ability to propagate vegetatively unusual variants makes inbreeding unnecessary except with seed-propagated plants.

Seedlings should be in the blooming stage for two or three years before they are discarded as they usually improve each year. Seedlings with undesirable colors can be discarded sooner as the colors do not change. Characters such as vigor, floriferousness, placement and flower size may improve as the plant grows older and larger.

FUNDAMENTALS IN PLANT BREEDING

The somewhat complicated terms and explanations plant breeders should come to know

Samuel L. Emsweller

PLANT breeding is a fascinating hobby that attracts many amateur gardeners. The first plant breeders probably were prehistoric men who, observing that some plants used for food were better than others, saved seed from the best for the next year's crop. We have no records that conscious selective breeding was practiced by our early ancestors, but the fact that certain types of corn and other grains are known to have gradually undergone improvement in prehistoric civilizations indicates that some form of selection was done.

Scientific plant breeding was explained by Gregor Mendel of Austria who published the results of his breeding work with garden peas in 1866. Although his report presented a lucid explanation of how plant characters were inherited and was well supported by ample evidence, the botanists of that period failed to understand his outstanding and fundamental discovery. His publication gathered dust on the shelves of the little Brunn Natural History Society in Austria for 34 years while speculation continued as to how plant characters were transmitted from one generation to the next.

In 1900, sixteen years too late for Mendel to receive the acclaim due his discovery, three scientists, H. de Vries (Holland), C. Correns (Germany), and E. von Tschermak (Austria), simultaneously discovered Mendel's paper and verified his results. From 1900 plant breeding became scientific: something over which man could exercise some form of control and predict results when certain plants were cross-bred.

The variations that occur in closely related plants may be caused by heredity or by response to the environmental conditions under which the plants are growing. Heredity determines that petunia seed will always produce petunias, but those of a particular kind may be very good or very poor, their quality depending in part on the gardener who grows them. Variations caused by environment are referred to as modifications and are not inherited.

Basic Principles of Plant Breeding

To carry on effective plant breeding, the breeder must understand several basic principles. Plants can be propagated by asexual or sexual methods. If a plant is increased by division or by cuttings, the method is called *asexual* and the resulting progeny is called a *clone.* No matter how many cuttings are made from the plants of a clone, they will all be identical. Many of the finest cultivated flowering plants and shrubs are clones, and even though millions of plants of a clonal cultivar exist, they are identical because they all trace back to one plant. Examples of such cultivars are the "varieties" of iris, tulip, narcissus, spirea, lilac, and many others.

Much time and effort are often wasted by amateur breeders who believe they can improve a clonal cultivar by selecting for propagation what they believe to be the better plants. Considerable effort, for instance, has been expended by some growers of Easter lily bulbs who have selected the more desirable single-nose bulbs for propagation, believing they would thus eliminate double- and triple-nose bulbs. If some plants of

a clonal cultivar are affected by a virus or any other disease, selection of the healthy individuals for propagation is, of course, advisable. This will result in restoring the stock to its original healthy condition, but will not change its heredity. Such selection is *not* plant breeding.

The second method of propagating plants is by use of seeds. This is referred to as *sexual propagation.* A seed originates as the result of the union of two sex cells: a nucleus in a pollen grain from the anther with a nucleus in an egg cell produced by an ovule formed in the ovary of the flower. If the pollen and egg cells are borne on the same plant or on two plants of the same clone, the seed is said to originate from *self-pollination;* if they are from two plants differing from one another in several or many characters, the term is *cross-pollination.* The sex cells are called *gametes,* those produced by pollen being the male gametes, and the eggs the female gametes. Each contributes equally to the formation of the embryo that will develop in the seed and eventually give rise to a plant. Following the union of the two gametes after pollination, a single-celled embryo is formed which grows into the mature embryo that occurs in every seed.

The gametes are single cells; and although very small, they carry within them the power to determine all the characters that will be possessed by the plant produced by their union. If a pollen grain is stained with a dye and placed under a microscope, a round dark-stained body called the *nucleus* is visible within it. If a section is cut through a stem, a leaf, or a root, a large number of cells, each containing a nucleus imbedded in a jelly-like substance called *cytoplasm* may be seen.

The role of the nucleus in plant breeding. The nucleus is the vehicle in the cell that carries the units which determine the heredity of a plant. The units are called *genes* and they are arranged very much like a string of beads on a body called a *chromosome.* In a few instances the cytoplasm also functions in heredity. Such cases are very rare, however, and the plant breeder may never be concerned about them. Each living cell in a plant contains a *nucleus* and all nuclei, except those in pollen and egg cells, contain the same number of chromosomes. For example, the chromosome number in all cells (except the gametes) of all ordinary Easter lilies is 24; that in all King Alfred daffodils is 28. The chromosome number of pollen and egg cells is always half that of all other cells in the plant. If this were not true, each time a pollen grain and egg cell united in fertilization, the chromosome number of the embryo produced would be doubled.

The cells that compose the body of the plant are called *somatic cells* to distinguish them from the sex cells, *gametes.* Somatic cells form the roots, stems, leaves and most parts of the flowers of a plant. The sex cells (pollen grains and eggs) are found only in the anthers and ovaries. When the cells of a plant with large chromosomes, such as lilies, are observed under a microscope, the chromosomes are seen to differ from one another in structure. Careful examination of the chromosomes of an Easter lily reveals 12 different kinds of chromosomes. There are 2 of each kind, one contributed by the pollen grain and the other by the egg cell at fertilization. Two similar chromosomes in a pair are called *homologues.*

How a plant grows and produces sex cells. All plants start as single-celled embryos. The embryo increases in size by successive cell divisions, each daughter cell receiving the same number of chromosomes. This is accomplished at cell division by each chromosome splitting lengthwise as if it were equipped with a zipper and by its two daughter halves separating and moving to opposite sides of the cell. A new cell wall is then formed between the two groups of chromosomes. This type of cell division is called *somatic mitosis.* Each new daughter cell will contain the full number of chromosomes. Such divisions are repeated many hundreds of thousands of times as the embryo develops in the seed

and finally produces a full-grown plant.

After the chromosomes split during cell division, the cell will contain twice the normal number of chromosomes if it fails to divide. Such an Easter lily cell will contain 48 chromosomes composed of 4 each of the 12 types. This condition is called *polyploidy;* and since each chromosome occurs in quadruplicate, the cell is called a *tetraploid.* If such a cell eventually forms a branch or a bulb, that part of the plant and the flowers formed by it will be tetraploid.

The sex cells do not appear until the flowers form. As the young flower develops, one group of cells forms anthers and others an ovary. At a certain stage of development of an anther, there are formed some cells in which the chromosomes do not split as they do in the type of division described for somatic mitosis. Instead, each chromosome closely associates with its mate, and when the cell divides the intimately paired chromosomes separate as whole bodies. The two new cells formed receive only one of each type of chromosome present and thus are *haploid,* having half the number of chromosomes found in all other cells of the plant. This type of cell division is called *meiosis* and from it arise the sex cells.

The Differences Between Mitosis and Meiosis

THE terms mitosis and meiosis apply to the nuclear division process which precedes the formation of new cells. *Mitosis* is the usual process of division of all cells in the roots, stems and leaves of plants. In contrast, *meiosis* occurs only in the formation of pollen grains and egg cells.

The differences between mitosis and meiosis in White Trumpet lily (*Lilium longiflorum*), are shown on the opposite page. This species has 24 chromosomes (the diploid number). Stages of *mitosis* are shown in A to E; comparable stages of *meiosis* in F to J.

In A the 24 chromosomes in a cell are preparing to undergo mitosis. Each chromosome splits lengthwise to form two identical chromosomes (B). The halves of each chromosome separate and move to opposite sides of the cell (C). Each new group of 24 chromosomes then forms a new nucleus and temporarily the cell has two nuclei (D); almost simultaneously with this stage, the cell divides to form two cells, each with 24 chromosomes (E). Thus, after mitosis, all cells have an identical makeup of chromosomes—the bearers of hereditary qualities.

In *meiosis*—the nuclear division that occurs when pollen grains and egg cells are produced—the number of chromosomes is reduced to 12. If this did not occur, each time a sperm cell from a pollen grain joined with an egg cell in fertilization, the chromosome number of the new cell would be double.

Meiosis of a pollen mother cell, which produces pollen, is shown in F to J. In F, the cell is in the first phase of division and its 24 chromosomes mate to form 12 pairs. Each pair consists of one chromosome that came from the female parent, and another that came from the male parent. Here, instead of splitting, whole chromosomes separate and move to opposite sides of the cell, as in G—12 chromosomes in each group rather than 24 (as in mitosis). It is at this point in the production of "sex cells" (pollen grains and egg cells) that different hereditary qualities are parcelled out to the daughter cells. Thus meiosis is the means by which variation is accomplished in hybridizing.

In H, each group of 12 chromosomes forms a new nucleus. Then each nucleus divides, the 12 chromosomes splitting as in B. The halves move to opposite sides to form four cells, each with a nucleus and all inside the wall of the original pollen mother cell (I). Each of the four nuclei contains 12 chromosomes. The pollen mother cell wall now disintegrates and releases the four cells. Each one is now a mature pollen grain (J).—S. L. E.


A
B
C
D
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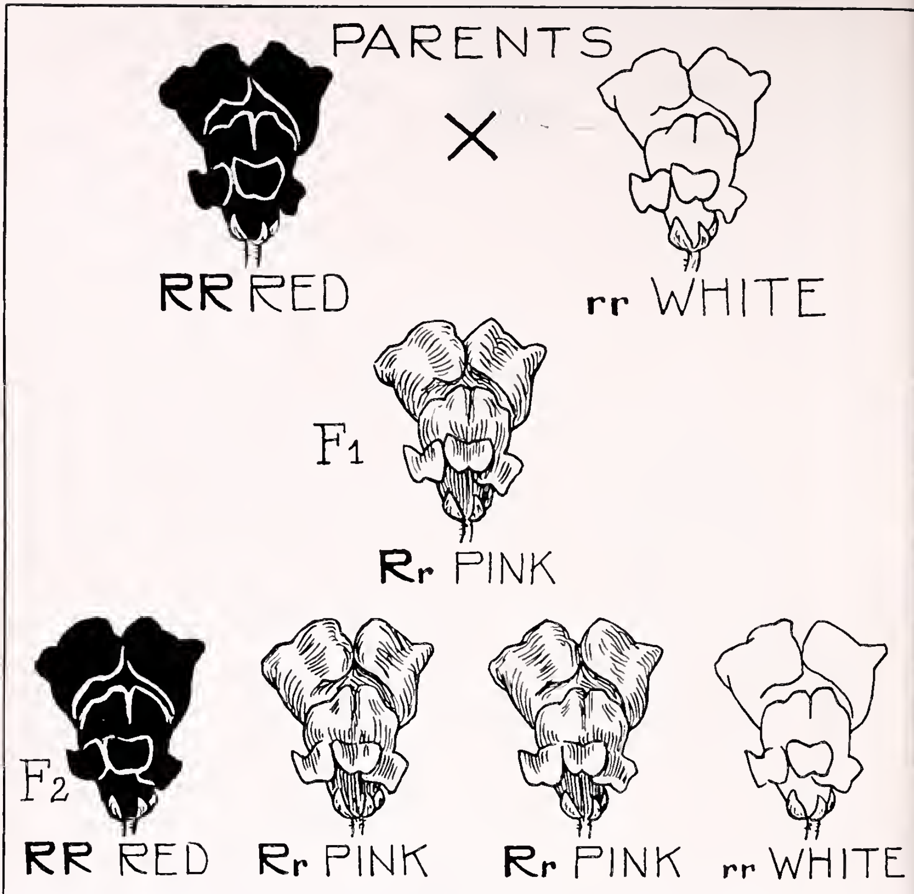
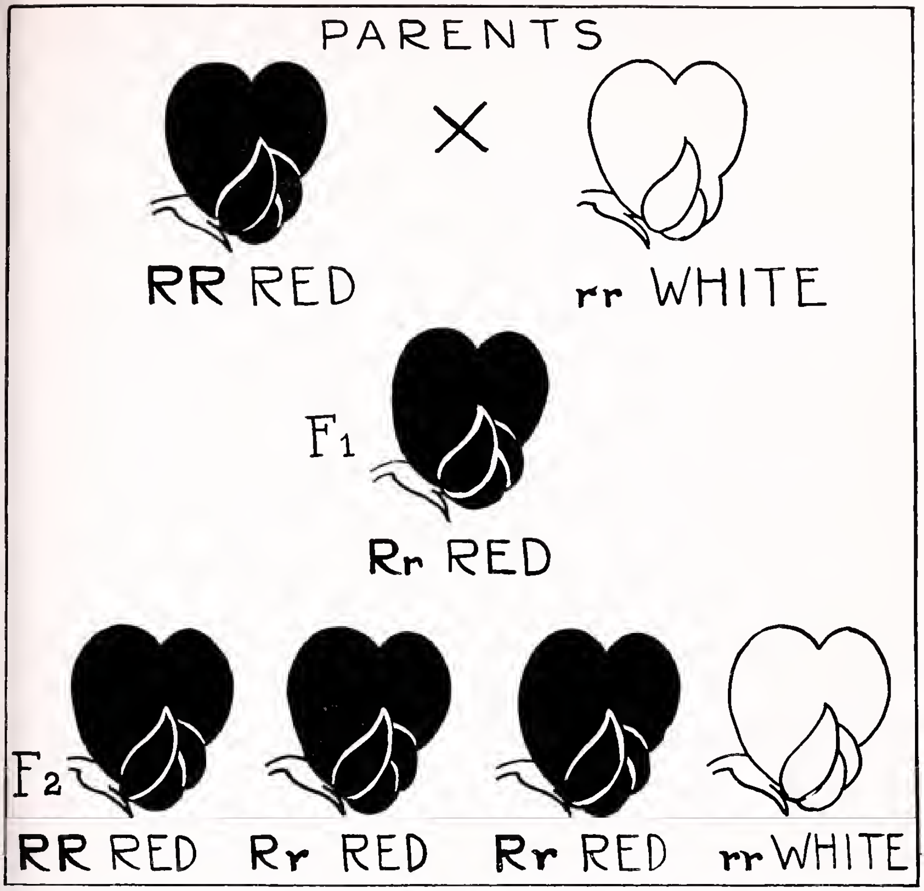


Incomplete dominance of flower color. Mendel's theory of heredity of such factors as flower color, is demonstrated above. In snapdragons, a red-flowered parent is crossed with a white. Red (indicated as RR), not being completely dominant over white (rr), gave plants that produced all pink flowers (Rr) in the first generation (F_1). However, when the pink-flowered offspring were self-pollinated, flowers on the second-generation plants (F_2) were one-fourth red, one-half pink, and one-fourth white. These are "Mendelian" ratios, and this illustrates one of Mendel's laws of inheritance

The role of the chromosome in plant breeding. As mentioned earlier, the chromosomes are the carriers of the genes that control the inheritance of the plant. The genes are arranged on the chromosome like a string of beads, and all the genes on any one chromosome will be inherited as a unit group unless something occurs to break and rearrange the gene string. The tendency to be inherited as a group is called *linkage,* and the genes in a chromosome are referred to as a *linkage group.*

Fortunately, linkage is broken by the exchange of pieces between two chromosomes as they pair during meiosis. This exchange of genes is called *crossing-over.* As a result of crossing-over, new combinations of genes are formed, and the greater the frequency of such gene interchange, the greater the variability to be expected in the seedlings obtained from a hybrid formed by crossing two plants differing in many characters. Since, because of linkage, genes are transmitted in groups, plant breeders are more concerned with whole groups of genes than with a few. Linkage often



Complete dominance of flower color. In this instance, when a red sweet pea (RR) is crossed with a white one (rr) the plants grown from the resulting seed produced red flowers (Rr) in the first generation (F_1). When these red-flowered offspring were self-pollinated, three-fourths of the second-generation plants (F_2) produced red flowers and one-fourth white, demonstrating the dominance of red color over white

makes it difficult to transmit desirable genes without carrying along undesirable, closely linked ones because they are located in the chromosome close to the desirable genes.

How plant characters are inherited. A gene is located at a specific place on a chromosome; this point is called a *gene locus.* A plant character, such as flower color (white, red, or perhaps pink), may be controlled by a series of genes. A group of genes, each one capable of affecting the same character in a different way, is called an *allelomorphic series.* The two chromosomes of a pair may each have the same gene of an allelomorphic series at a given locus and if so the plant is called *homozygous* for this particular character. When, however, one chromosome of a pair carries a gene that determines that the color of the flower shall be red, and the partner chromosome carries the allelomorph gene for white, the plant is called *heterozygous* for color. Such a plant is said to be a hybrid for color although it may be homozygous for many other genes. The flower color may be red or white, depending on which gene is dominant. If the flower is red, the gene for red is said to be *dominant* over the white gene, which is called *recessive.* Sometimes neither gene is fully dominant

and the color of the flower may be intermediate. This condition is referred to as *incomplete dominance.*

If a plant is heterozygous at a given locus, only the dominant allelomorph will be able to express itself in the hybrid. The recessive gene, though present, is unable to function. In homozygous plants, the gene present can express itself either as a dominant or homozygous recessive. When self-pollinated, a plant will breed true for the color gene it happens to have. If, however, the plant has one red dominant gene and its allelomorph is a recessive white gene, the plant will have red flowers and will not breed true when self-pollinated. In the next generation, three-quarters of the plants will exhibit the dominant character and one-quarter the recessive character.

When a recessive character appears in a plant it indicates that both genes controlling the character are recessive, and the plant is homozygous for that character. Describing in detail does not tell whether the plant will breed true because all the recessive genes present will not be able to express themselves unless they are homozygous. A description of the observable characters of a plant is called the *phenotype* of the plant. It is impossible to know all the genes in a plant, and the inheritance of but a few are studied at one time. When the genes present for a character or a group of characters are known, they are referred to as the *genotype* of the plant for these particular characters.

Since there are dominant and recessive genes, a hybrid should always be bred into successive generations so that plants with the recessive characters may be obtained as well as those with the new recombinations of genes resulting from the crossing-over that occurred in the hybrid.

When two plants are crossed to obtain a new plant combining the best qualities of each parent, the hybrid is called the F_1. If the F_1 plants are self-pollinated or intercrossed, the next generation is the F_2 and succeeding generations obtained in the same manner are called F_3, F_4, etc.

The backcross method of plant breeding. A plant may possess relatively few good characters and many poor ones. When it is crossed with another plant that has many good characters, plant breeders may utilize the backcross method of breeding. This consists in crossing the F_1 hybrid with either parent. It enables the breeder, by repeatedly crossing back to the better parent, to accumulate the desirable genes more rapidly. If the desirable genes of the poor parent are recessive they will not appear in the hybrid. It then becomes necessary to utilize self-pollinations as well as backcrosses in each generation to discover what plants possess the desired genes. In each generation the breeder can select, for backcrossing to the better parent, those plants showing the presence of the best genes of both parents.

Mutations. The sudden appearance of a new character in a growing plant is called a *sport,* or a *mutation.* These fortuitous changes may occur in branches, in flowers, or in any other part of a plant. They may be due to a change in a gene or in its location in the chromosome or to a structural rearrangement of the genes in a chromosome. Sometimes a mutation occurs in plant tissues that do not give rise to sex cells. Such mutations are not heritable and are called *chimeras.* When it is possible to propagate a mutation asexually it may be considered a *new cultivar* or *strain.* These sudden changes are responsible for the origin of many cultivars of roses, carnations, and other plants. The rose cultivar Ophelia has produced many mutants, and certain chrysanthemums mutate with such a high frequency that they have been discarded by florists.

The plant breeder has no control over the frequency or type of mutations that appear and merely being the owner of a plant that does produce a valuable mutation is similar to winning a sweepstake. The appearance of mutants must be accepted as an accidental event, not as the result of plant breeding.

THE ROLE OF THE AMATEUR BREEDER

Glenn Viehmeyer

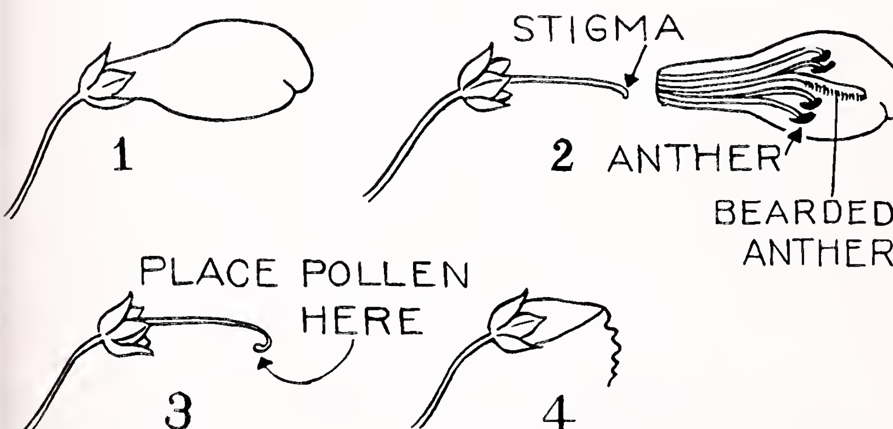
SO you would like to breed plants and take part in this fascinating game of creating new ornamentals, fruits and vegetables for gardens everywhere. There is no reason why you cannot, and every reason why you should do it. As a matter of fact your help is badly needed, and you can play an important role in developing useful plants for your particular region.

As an amateur you have advantages we professionals can't enjoy, you can try things that we cannot try. We work under a certain pressure; you work under no restrictions, except those of time and space available to you.

In my opinion, the amateur breeder can and will be the greatest single factor for horticultural progress in the field of ornamentals. I say this in all sincerity. The reason is simply that there are hundreds of you to dozens of us. You are scattered everywhere from north to south, from east to west. As a group you will be working in all the diverse environmental conditions of the continent. This, alone, gives you an immense advantage over the professional.

As any competent plant breeder or geneticist will tell you, the best place to produce a new plant for a garden is in that garden. Actually, the environment of your garden is one of your more important breeding tools, if you use it properly. In my breeding work I consider environmental effect my greatest help in producing better plants. After all, Mother Nature has been in the game far longer than has man and we can use her methods to our advantage.

At North Platte we let Nature, through the habitat effect, make a lot of decisions for us. This saves considerable work and does a better job than we could possibly



author's sketch

Diagram of pollination of penstemon flower. 1. Diagram of a penstemon bud, ready for emasculation. 2. Emasculation of flower, i.e., petals with stamens pulled away, leaving the stigma exposed. Penstemon has four pollen-bearing stamens and one that is sterile and bearded. The latter gives rise to the popular name of this flower—"beard-tongue." 3. Emasculated flower with pistil ready to receive pollen. 4. Two weeks after pollination; the seed capsule (botanically the fruit) is forming

do otherwise. For example, in breeding for hardiness in chrysanthemums or roses we grow populations in the open field where they will have to take what the climate serves them, or die. Furthermore we go over the survivors and discard those with obvious winter damage. Rough treatment? Sure it is, but it eliminates those unfit to flourish under our climatic conditions.

"Adaptedness" is the primary goal of a plant breeder, whether he recognizes that fact or not. Without it no plant succeeds without special attention and excessive care. Unfortunately many breeders, both amateur and professional, fail to recognize the importance of adaptedness and release plants that are poorly adapted to the environment in which they will be grown.

The amateur, breeding for his own garden or for his immediate neighborhood, has a big advantage over the professional. The latter must breed for *wide adaptation* while the amateur breeds for *local adaptation.* To illustrate this, I breed for widely adapted chrysanthemum varieties and average about one mum, that merits release as a variety, from two to three thousand seedlings. If I were breeding for local adaptation I could expect up to a dozen worthwhile mums from as few as a hundred seedlings. Both the amateur and the professional have their place in a well-rounded breeding program and complement each other in the overall program.

There are a few principles that the beginner should remember if he is to do an effective job in his avocation.

First:

Never forget this basic truth. *Whatever you put in a hybrid is still there and can be recovered in later generations, if you grow large enough populations.* The first generation hybrid may be, and frequently is, utterly worthless as an ornamental but don't discard it. The parental characters that you wished to combine are there even though they are not visible and you will recover them in the second and later generations. *Always carry hybrids into the advanced generations.*

Second:

Perennial plants that can be propagated asexually are generally more satisfactory to the amateur. If you get something worthwhile you can increase it by vegetative means and thus preserve it.

Third:

If you choose to work with annuals you can expect to spend several years in purifying a new strain.

Glenn Viehmeyer pollinates chrysanthemum flowers by dabbing the head of a flower with pollen stored in labelled jar lids shown on the work table. A cotton-tipped toothpick is used for applying pollen. Pollinated flowers, kept fresh in jars of water, set plenty of seeds indoors. He wears 6-power jeweler's glasses to inspect the flowers

Fourth:

Learn everything you can about the plant you are working with. Frequently you can save much time and effort by knowing what has been done with it in the past.

Fifth:

Don't expect every cross you attempt to succeed. The more distant the relationships between the parental material the fewer successful crosses. Crosses between varieties of a species are easier to make than crosses between species.

Sixth:

Don't be afraid to fail; if you miss the first time, try again. Make a lot of crosses in hopes that a few of them will succeed. One of the biggest jobs in starting a breeding program is discovering which parents cross readily and produce desirable offspring.

Actually, any plant may be improved through breeding. My first advice to the amateur is, "Choose the plant you are most interested in and go to work with it." Below are listed some genera that seem to have considerable promise.

Aster

This is the perennial aster, not the annual "China" aster. Aster is a big genus of perennial herbs with many wild species as well as a great number of cultivated varieties. In the wild they grow from desert to swamp and from mountain top to seashore. They range from little plants a few inches high, to giants taller than you are. Somewhat limited experience with them has indicated a rather wide range of compatibility between species. Many of the wild natives cross with each other and with the cultivated kinds. Indications are that many individual plants are highly self-sterile and that foreign pollen, even that of another species, is more likely to effect fertilization than is the plant's own pollen.

Chrysanthemum

The garden chrysanthemum is a "natural" for the amateur breeder. This plant is highly sensitive to slight differences in climate and is a prolific producer of locally adapted varieties, but not of widely adapted ones. Garden varieties cross readily with the big greenhouse kinds and the resulting hybrids are often outstanding. Breeding methods are not difficult and seedlings are easily grown. Seedlings will bloom the first season from seed. Here is a place where we can use a lot of amateur breeders and I will send a bulletin, "Chrysanthemum Improvement," to any reader without charge. In our opinion we are just beginning to scratch the surface of mum improvement and the field is wide open.

Dianthus (including carnation)

Interspecific hybridization and varietal crosses of dianthus promises much to the novice. Flower parts are large and manipulation is easy. Wide crosses often result in "female sterile" hybrids that are everblooming because of their sterility—they just keep trying unsuccessfully to produce seed. Many of the hardy species cross readily with greenhouse carnations and produce excellent ornamentals. For example, the English variety 'Delight' crossed with carnation results in female-sterile, everblooming, offspring. Most species are cross-fertile and there is no limit to the range of types and colors that may be produced.

Penstemon

Here is a genus of plants native to North America that you will be hearing more about. This genus long resisted the efforts of the plant breeder but within the past decade methods of circumventing barriers to hybridization have been discovered. At the present time there are many interspecific hybrids available to the amateur plant breeder through the American Penstemon Society's* seed ex-

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* Mrs. Edward M. Babb, Secretary, 215 Lambert St., Portland, Maine.

change and a number of new ones appear in their list each year.

Penstemons are "a natural" for the novice breeder. Flower parts are large and easily manipulated, each capsule may contain as many as sixty or more seeds and emasculated flowers need not be bagged to protect them from insects. Further, penstemon breeding is an area in which we need many workers to take advantage of the material available, which consists of species hybrids between different sections of the genus. Some of the hybrids may include germplasms from as many as six botanical sections. Most of these "raw hybrids" are interfertile, making still more complex combinations possible, or they can be used as segregating material from which the grower may select clones particularly well adapted to his own garden.

Rose

Rose lovers, who live in the colder parts of the country, can do a real service to their favorite flower by joining the breeding game. Most present varieties lack the hardiness and vigor needed in severe climates. Just a few more degrees of cold tolerance would put roses in many more gardens.

Fortunately, the groundwork for hardier roses has been laid. We have many species hybrids that are hardy and that will cross with hybrid tea and floribunda roses. Such kinds as Frulingsgold, Golden Wings and Pike's Peak are promising as parents. The old roses, such as the gallicas, the mosses and centifolias, can add hardiness to the modern kinds. *Rosa spinosissima* and its various hybrids are a source of hardiness and vigor that might well be combined with the quality of the modern rose.

Most gardeners are unaware of the fact that roses are not difficult from seed, that many seedlings bloom the first season and almost all bloom the second summer. This makes rose breeding but little slower than breeding perennials or even annuals and the rose is definitely a plant that the beginner might consider. Indeed, I believe that the beginner is our best hope for hardier roses for the colder parts of the country. Most commercial operations are located in areas of mild climate and if we want hardier roses it is up to the breeder who works in the more difficult areas of the country to produce them.

Space does not permit me to cover more than a fraction of the areas where the amateur breeder may serve horticulture. His role is an important one that will increase in importance as time goes by. It is limited only by the scope of his imagination and his willingness to adventure beyond the known.

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Spring 1948:58. The Iris Breeder's Objectives, John Dolman, Jr.

Summer 1948:117. New Kinds of Plants by Chemical Treatment, Betty F. Thomson

Spring 1949:58. The Glenn Dale Hybrid Azaleas, B. Y. Morrison

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Winter 1956-57:278. Discover the F_2's, Howard Bodger

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SAUNDERS' HYBRID PEONIES*

Silvia Saunders

ABOUT the time of the first World War, Dr. Arthur Percy Saunders began to acquire some interesting species peonies, and to make the crosses that later resulted in many distinguished and beautiful new strains of peony hybrids.

Dr. Saunder's first species were acquired from European nurseries. They were: *Paeonia lutea* (the wild yellow tree peony from China), and three herbaceous species: *P. lobata* (one of the many forms we group under the name officinalis, native to Southern Europe), *P. macrophylla* (large-leaved, white-flowered), and *P. mlokosewitschi* (the only true yellow in the herbaceous group)—the two last from the Caucasus mountains.

Dr. Saunders already had in his garden several dozen fine Japanese tree peonies, and several hundred varieties of *P. albiflora*. The records of these years show that each of these six species or groups was crossed on every other group (and then the whole process again, the other way around, which produces entirely different results).

By 1924 there were hybrids in his garden the like of which had never been seen before.

Coincidentally, at least two other American peony men were making peony crosses—and albiflora-officinalis hybrids began to appear at national peony exhibits from several sources. Those of Edward Auten, Jr., and the late Lyman D. Glascock were outstanding examples. Not only did these hybrids win medals and awards, but they also inspired in the public a desire to possess these new beauties for their gardens.

There were three strains among the first Saunders hybrids to make public appearance—the Challengers (*P. albiflora* x *P. officinalis*), with huge single crimson-red blooms on tall, stiff stems, and foliage almost tropically luxuriant; the Chalice strain (*P. albiflora* x *P. macrophylla*), whites of an ethereal and shimmering beauty; and a group called the Virtues (*P. albiflora* x an officinalis known as 'Otto Frobel'), clear, bright pinks at that time the nearest to a true salmon shade. The Virtues have now been superseded by later and finer pinks; but the Chalice and Challenger groups remain permanent garden contributions.

In 1928, there arrived from Amos Perry in England a variety of lobata which, in bloom the following June, was of a peculiarly vivid scarlet red, and which was immediately crossed onto the albifloras then in bloom. Because this cross was reputed to take rather poorly, over 100 crosses were made that year. To everyone's astonishment, the cross was a mad success and no less than 2,200 seeds were gathered in the fall.

Five, six, and seven years later, in mid-June when the resulting 1,300 seedlings began to bloom, every one was either a glorious red or a vivid pink.

The colors were all new to the peony world, and all beautiful—not a "purplish" red nor a "too blue" pink in the lot—salmon, coral, cherry pink, vermilion, scarlet, cerise. Some forty of these lobata hybrids have been introduced to the public. Their names—such as 'Janice', 'Laura Magnuson', 'Nathalie' (for Mrs. Joseph Swan), 'Alexander Woollcott,' 'Carina', 'Cardinal's Robe'—are now well known. Their originator, and those who grow them, feel that this is one of his outstanding horticultural contributions.

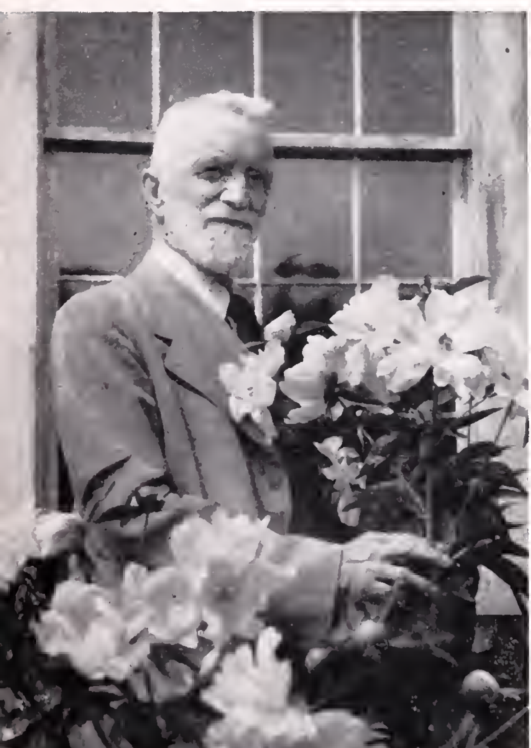
Dr. Saunders never succeeded, as did Dr. Earle B. White, in persuading the distinguished but cautious *P. mlokosewitschi* to cross with the albifloras. But he did cross it with *P. tenuifolia* (the tiny fern-leaved early crimson, from the

*Reprinted from the July, 1959 "Bulletin" of The Horticultural Society of New York

Caucasus mountains), producing hybrids which in their turn were successfully crossed onto albiflora. (This is called the "backstairs" method of bringing mloko and albiflora together.) A group of lovely "triple" hybrids resulted: 'Roselette' (tall pink), 'Rushlight' (ivory yellow), and 'Sprite' (appleblossom white). All bloom in May.

"Mloko" was also successfully crossed onto its other Caucasian neighbor, *P. macrophylla.* This geographical affinity is odd, for the three species do not seem—by appearance or chromosome count—to be at all closely related.

These "mloko-macro" hybrids were later crossed onto officinalis, and the triple hybrids that resulted were in their turn crossed onto albiflora, creating a strain of "quadruple" hybrids. Of these, the best are perhaps: 'Firelight' (the only pink), 'Lady Gay,' 'Rose Noble', and 'Starlight.' These plants bloom in late May. Their outstanding characteristic is the ivory sheen, almost opalescent, of their flowers. Many are dramatically flared like the Japanese tree peonies. They are quite unlike any other hybrids, and represent a true hybridist's triumph. 'Starlight' is pale ivory yellow, closely resembling in shape and shade of flower Dr. White's famous 'Claire de Lune', the only known hybrid between albiflora and mlokosewitschi.



Over the years, Dr. Saunder's Clinton (N. Y.) garden came to house the largest collection of species peonies in America. Many thousands of crosses were made there, and many hundreds of hybrids resulted. Some of the best are these:

The beautiful Himalayan species, *P. emodi*, fathered two lovely early hybrids, the 'Windflowers', and a handsome tall late variety, 'White Innocence.' "Late" for a hybrid is mid-June.

'Picotee' is from *P. corsica* x *P. macrophylla.*

'Halcyon'—from albiflora by a "species" called *P. ozieri alba,* the plant now lost, the name unknown anywhere.

The Lavenders came from albiflora x coriacea.

'Diantha', an early delicious pink, from officinalis x decora alba. These represent the peaks of accomplishment in the herbaceous field.

Among the tree peonies, another cross introduced to our June gardens a great race of hardy yellow-flowered plants, the lutea hybrids. These were not the long-hoped-for offspring of mlokosewitschi—her children have never produced better than the palest primrose yellow, and few indeed of these. Rather, *P. lutea* (Latin for "yellow") is the mother of this strain. Tree peonies are not trees, but shrubs—with woody stems that remain above ground all winter, and from which leaf and flower buds sprout in spring. In this somewhat intemperate section of New York, however, these plants die back like any herbaceous perennial and sprout again from the earth in April. *P. lutea,*

A. P. Saunders, pictured when he was 84 years old, with his hybrid peony 'White Innocence'

'Lady Gay' is one of Dr. Saunders' quadruple hybrids—ivory with deep rose flares

'Canary' is a Saunders lutea hybrid which has the brightest yellow color

individually a rather spindly plant, makes a nice clump when grown from seed; and this is easy—really easy. The small globular blooms with their modest habit of hanging over into the ferny foliage, are in various shades of bright butter-yellow, tawny, orange, red, and on into dullish crimson and maroon—for there are a number of different forms closely related to lutea, all of whom appear to entertain the friendliest relations with one another.

When Japanese tree peonies were crossed onto *P. lutea,* a cross that takes fairly easily, a series of rather spectacular hybrids resulted. The great Lemoine was first, and thus far the only other, to make this cross. 'Maxime Cornu,' 'Chromatella', and some ten others are the work of his distinguished hybridizing hands. He began in the nineties with the first plant of *P. lutea,* sent from China to the Jardin des Plantes in Paris.

Dr. Saunders' first hybrid, 'Argosy', which has now been known to the public for some thirty years, is a fine single yellow. An established plant may be 6 or 8 feet across, 4 feet tall, and bear from 50 to 75 blooms. Following 'Argosy' has come an array of plants with flowers ranging from yellow (pale, creamy, amber, or deep gold) through tea-rose, red-gold, dusky- rose, strawberry red, to crimsons both dull and brilliant, and dark, almost black maroons. Some are delicately or dramatically streaked and blended. Almost all are singles, the most double being prettily-shaped rosettes. They bloom about the second week in June.

Here, in a few words, is the story of a lifetime spent with the peony—first as a hobby, then as a scientific pursuit, but always with ardour. New colors have been introduced; the season of bloom has been almost doubled; and hybrid strains have been given to the world which may be—who knows?—only the beginning of still further and as yet undreamed-of variations and improvement in this beloved plant.

HYBRIDIZING TREE PEONIES

William Gratwick

TREE peony hybrids are the result of crossing *Paeonia suffruticosa* (moutan) with *P. delavayi* and *P. lutea.* The former has large characterful flowers held high on a strong stem, in all colors from white to pink, red, black-red and purple. The latter two have small butter-cup-like flowers growing on a weak stem, in colors ranging from yellow and orange to red and deep maroon.

The hope of the hybridizer is to produce a plant which adds the colors and form of flower of *P. lutea* and *P. delavayi* to a plant which resembles *P. suffruticosa* in character of growth. Too many of the hybrids made so far inherit the weak stem of *P. lutea;* and this, combined with the greater size of the flowers, has resulted in plants with flowers drooping down under the foliage.

I had the great good fortune to work with Professor Saunders for a number of years, doing his grafting for him when he was no longer able to continue it. During this time I started hybridizing in my own nursery. I believe I was the first to make the cross "the other way" in that I used the pollen of *P. lutea* on a Japanese variety. I also grew many hundreds of *lutea* seedlings, and selected several which were outstanding because of their strong stems. By using these parent stocks I have added a few new varieties which seem to be comparable to the best of the Saunders strain.

But my job, I felt, was not to continue making this first cross; it was to get into the next generations—the F_2 and F_3 generations. Professor Saunders had entrusted me with two F_2 plants which he had grown from the seeds which the first generation hybrids very occasionally produce. Neither one of these plants was much to look at in flower, and both were apparently sterile; but I promised to get something from them if it were humanly possible.

And it has proved to be possible. Credit for success goes to my friend and partner Nassos Daphnis, who spring and fall during the last 15 years has devoted his entire time, insight and determination to the task.

A cross-pollinating program which included every possible combination the nursery had to offer was planned. And, in at least a limited way, it has been accomplished. We found, in the first place, that although the Saunders F_2s were self-sterile, they were fertile when crossed with each other, and with the F_1 hybrids. It was also possible to cross them back on the parent *lutea.* We have about 100 new hybrids representing these combinations. The first of them may bloom next year.

But until 1956 the most important cross —a plant with 75 per cent of the Japanese genes and 25 per cent of *lutea*—never "took". A hybrid with this pedigree, it seemed to us, would have the best chance of combining the finest qualities of both parents, so we decided that an exhaustive try should be made. A "try" involves opening up the flower 3 days before it is ready, emasculating it, covering the pistil with a paper bag, going back 3 to 4 days later with the F_2 pollen, replacing the bag, returning again after the pistil has dried up to remove the bag and tag the stem. This procedure was followed by Nassos on 1000 flowers, and we calculated that we had a possible 50,000 chances for a take.

So far so good. The summer went by. The day of harvest finally arrived. The crop? One seed! But a fertile one—and in two years it is above ground. Now, today in 1959, it is two years old. Possibly in three years we will have the first flower. It may be the first of a whole new race of tree peonies. Whatever it turns out to be, at least it will be evidence that we are still busy at the job turned over to us 20 years ago.

DAHLIA BREEDING

Clement W. Ballay

IN the past 25 years or more, there has been marked advancement in dahlia quality—a richer and wider range of color, better habit of growth, and improvement in form and size. Nevertheless, there is still much to be done. It cannot yet be said that there is a perfect dahlia.

As in all plants, new varieties are grown from seed obtained through hybridization. When we speak of hybridizing dahlias, we mean that a definite cross has been made between two varieties of dahlia. One would assume, naturally, that the seed parent has been prevented from being fertilized by any other than the pollen parent intended. In actual practice, this is not easy to do and is not what is meant in catalogues or dahlia publications when reference is made to "hand-pollinized" seeds. In fact, it is almost impossible to determine in dahlias that a definite cross has been made, except with the utmost patience and care.

In order to get seed which will yield worthwhile flowers, it is all-important that nothing but first-class varieties be grown in the patch, so that chance crosses made by bees, wind, etc. are not a detriment.

For seed purposes it is well to plant early, because the first blooms rarely produce seeds, and if seed-maturing time is late, the seed heads frequently rot before they can ripen.

For ordinary purposes the simplest procedure is this. When the bloom selected for the seed parent has opened and is showing pollen, bring pollen from the male parent freely and frequently. The pollinated center of a bloom itself can be used as a brush. This method will guard against unfertilized seeds. Of course, the pollen of both flowers may already have been contaminated with pollen from other blooms, but what is the difference if all varieties in the patch are good.

Keep the drying petals pulled off. Seeds can be shelled from the pod before fully dry if there is a tendency for them to rot.

Naturally, many of the seedlings will not resemble the parents. A really good seedling is not easy to get. Some may be pretty enough, but have no commercial value, judged by today's high standards.

For those who wish to take a more scientific approach to the subject, and there are some dahlia growers who do and it is to be recommended, this is how to proceed. To begin with, it is well to know the pedigree—that is the ancestry—of the varieties to be bred. The qualities present in "good blood lines" count in other things, and should be helpful here too. When the blooms to be used in making the cross have been selected, cover them well before the pollen develops. When the pollen has been brought to the seed parent, the blooms should immediately be "hooded" or covered again until the next application.

Whether a bloom can pollinate itself is not certain, but this seems possible since a single plant, growing by itself, sometimes sets seed. If self-pollination is possible, then again, as I mentioned in the beginning, one cannot be certain that a definite cross has been made. Some growers believe that there is added protection from growing the plants for experimentation in a cloth-house or even a glass-house.

Dahlia plants may have virus diseases. It is believed that such diseases are not transmitted through seed, but only through propagation from root divisions or plant cuttings. Where disease is apparent, it is best to destroy the plants, and indeed never use them as parent plants for hybridizing.

A SCIENTIFIC APPROACH TO IRIS BREEDING

Katherine H. Heinig

THE popularity and usefulness of tall bearded iris have been increased greatly in recent years by the development of large numbers of improved tetraploid varieties whose flower size, form, range and clarity of color far surpass the diploid varieties formerly grown.

While tall bearded iris are most commonly grown and far outrank the others in importance as garden subjects they represent only a portion of all the iris available for use by the gardener and hybridizer. Today, increasing attention is being given to the development of other groups of iris too.

In the last ten years new types of early blooming dwarfs and intermediate bearded iris have been developed, and interesting forms have been created through interbreeding Eupogan, Oncocyclus and Regelia iris. The appearance of these new varieties has necessitated the establishment of new horticultural groups and has stimulated the search for and importation of wild iris to be used in the development of new and improved horticultural types.

Objectives

The future will doubtless see the development of deeper pink, truer red and blue tall varieties, and green iris certainly are a definite possibility. Improvements may be expected in the plicatas, bitones and reverse bicolors. There is also need for emphasis in breeding for disease resistance, greater vigor, longevity of bloom and extension of the flowering season through the development of early spring and autumn blooming types. Efforts are being made to prolong and enrich the iris season through the development of early dwarfs, dwarfs and intermediates which will bloom with the tall bearded, miniature tall iris and border iris. New types of garden iris are being sought by utilizing newly imported species in breeding programs.

Among beardless iris, significant improvements are being made in the Spuria and Siberian groups whose development has lagged far behind that of other groups; and attention is being given to the development of garden varieties from Louisiana and Pacific Coast species. Present efforts to improve these groups are meeting with success. Louisiana iris in particular are better adapted to growing conditions in the extreme south than are bearded iris which do poorly there.

Significance of Botanical Relationships

In iris, perhaps more extensively than in any other ornamental plants with the possible exception of orchids, the development of new varieties has resulted from hybridization between species. With few exceptions the varieties grown today are first or advance generation hybrids of different species. Many iris species hybridize readily and natural hybrids are often found where species grow in close proximity. Several well-known species, such as *I. pumila*, *chamaeiris* and *versicolor*, are in fact of hybrid origin. Although crosses involving iris species belonging to the same or different subdivisions of the genus often produce fertile or partially fertile hybrids, genic and chromosomal dissimilarities may serve as barriers to crossability. Since hybrids are usually obtained more readily from closely related species, a knowledge

of botanical relationships is helpful in iris breeding.

Natural Relationships of Species

The genus *Iris* is composed of somewhat more than 200 species of which more than half are grown in gardens and used in hybridizing. Botanically these are grouped into four subgenera. The subgenus **Xiphium**, which includes the Reticulatas as well as the Spanish, English and hybrid Dutch iris, and the subgenus **Scorpiris** or Juno iris are bulbous. Their native habitat is the Mediterranean basin, southeastern Europe and Iran. The subgenus **Nepalensis** consists of a single species, *I. decora*, occasionally grown for its lovely evanescent flowers. The more common garden iris are rhizomatous and comprise the large subgenus **Iris.** This last subgenus includes the bearded Eupogon, Oncocyclus and Regelia iris and the beardless Spuria, Japanese, Siberian, Louisiana and Pacific Coast iris as well as the crested iris or Evansias. In general the beardless species have a circumboreal distribution in temperate latitudes, while the Evansias are restricted to eastern North America, Japan and China. The bearded iris, however, are not native to the New World. The Eupogons are widely distributed throughout southern Europe, the Mediterranean basin and northern India; the Oncocyclus and Regelias are to be found only in the Middle East and southern Russia.

Chromosome Relationships

To utilize iris species and varieties most effectively in breeding it is necessary to know their chromosome numbers.

With rare exceptions all the individuals of a species have the same number and kind of chromosomes. Although related species may have the same chromosome complement or karyotype they often differ in chromosome number, in various structural features of the chromosomes, or in the kinds and arrangements of their genes. Among bearded iris, the basic chromosome number in Eupogons is 8 or 12, in Regelias 11, and in Oncocyclus 10, and some of their chromosomes differ in form also.

Polyploid species with chromosome numbers in multiples of the base number are to be found in various sections of the genus and several have proved to be extremely valuable in breeding.

Incompatibilities and Sterilities

It is well known that amoenas, neglectas and variegatas are difficult to cross and as a consequence progress in breeding of these interesting color patterns has been greatly retarded.

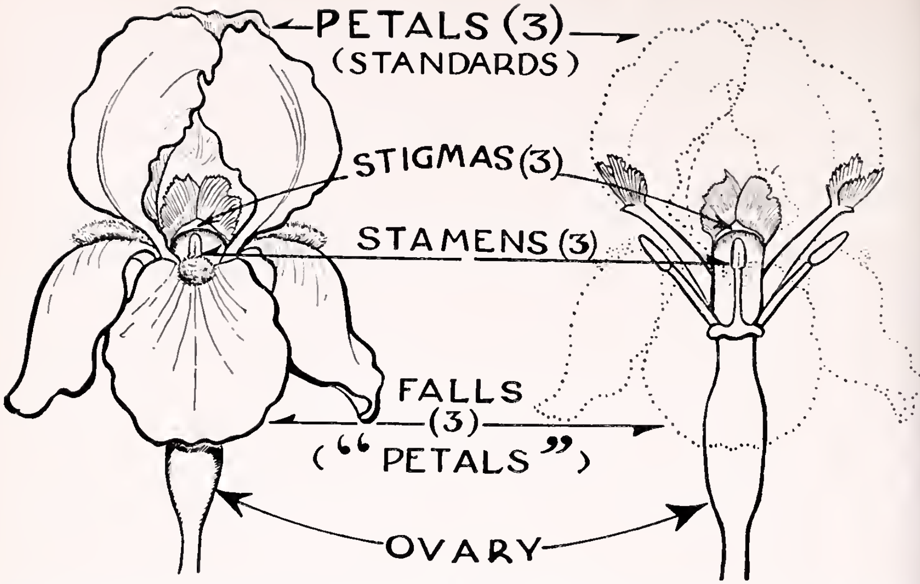
The varieties 'Snow Flurry,' 'Extravaganza' and many others produce aborted stamens, but male sterility of the sort involving the production of nonfunctional pollen in normal stamens, has not been conclusively demonstrated in iris. However, sterility due to defective male and female gametes is often characteristic of species hybrids.

The chromosomes of hybrids involving genetically dissimilar parents may not pair regularly during meiosis and as a result normal, viable gametes are not produced. Irregularity in chromosome pairing is also characteristic of hybrids between species with different chromosome numbers. This ordinarily reduces the fertility of the hybrids and prevents their further use for breeding purposes.

Species of Promise

Improvements in garden iris will continue to be achieved through intensive breeding of existing varieties, and there is increasing evidence that new types will be produced through the imaginative use of various species hitherto not widely used in hybridizing.

Dwarf Bearded Species: Although all of the Eupogon dwarf species may be intercrossed and crossed with diploid and tetraploid tall bearded species to produce various sorts of dwarf and intermediate hybrids, a few are particularly noteworthy. These are the 32-chromosome tetraploid species, *I. pumila*, the 48-chromosome tetraploids *I. balkana* and



Sketch of intact iris flower; parts of the flower are in 3's or multiples of 3, a characteristic of the iris, lily, amaryllis and some other plant families. *Right.* Standard and falls are removed to show position of the 3 stamens and 3 stigmas

I. aphylla, and the 24-chromosome diploid species *I. mellita, reichenbachi* (*bosniaca*) and *rubromarginata.*

The species *I. pumila* has proven especially valuable as a parent. Not only have many attractive miniature dwarf varieties originated from this species but crosses of *I. pumila* with 48-chromosome tall bearded varieties have produced an interesting new group of fertile hybrids many of which resemble the well known chamaeiris dwarfs, but are superior in flower form and color. The varieties 'Green Spot,' 'Fairy Flax,' 'Pygmy Gold' and 'Blue Denim' were produced in this way and limitless possibilities are yet to be tried.

Tall Bearded Species: Recent breeding has indicated that new gene combinations resulting in distinctive new varieties may be obtained from intercrossing existing tetraploid varieties and various untried diploid species. The variety 'Wide World,' a tetraploid hybrid obtained from crossing the diploid *I. imbricata* with a tetraploid tall, is a striking blue and white reverse bicolor quite different from any other tetraploid variety. *Iris perrieri, reginae* and *rudskyi,* species recently imported, may be the source of still other genes.

Beardless Species: Most of the breeding being done at present with beardless types is restricted to Spuria and Louisiana iris. Spuria varieties of excellent garden value have originated from crosses of *I. spuria, ochroleuca, monnieri* and *aurea.* The improvement of Louisiana iris has involved the use of three closely related species, *I. fulva, brevicaulis* and *giganticaerulea,* and their naturally occurring hybrids. The Louisiana species give every evidence of having as much inherent genetic variability as the species from which tall bearded iris have been developed.

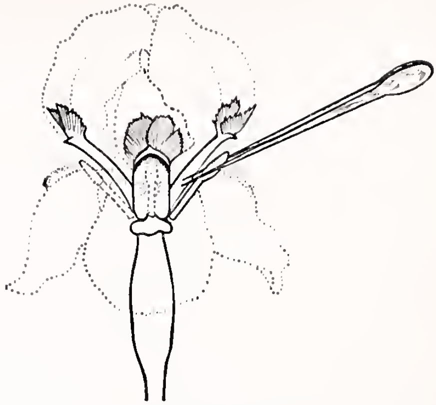
Several attractive hybrids have been achieved from crosses of the Pacific Coast species *I. innominata, douglasiana* and *munzi,* and from crosses of these species with Siberian iris. The latter hybrids are, however, highly sterile. Most of the garden varieties of Siberian iris are hybrids of the 28-chromosome species

I. siberica and *I. sanguinea (I. orientalis)*, although interesting varieties might also be achieved through the interbreeding of the 40-chromosome species *I. forresti, clarkei, delavayi, chrysographes, wilsoni* and *bulleyana.*

Breeding Methods

New iris varieties may be achieved through interspecific hybridization and by outcrossing of existing varieties to basic species. However, though genetic variability may be introduced through hybridization and some first generation hybrids may have distinct garden value, further breeding is usually necessary to isolate and perfect desirable combinations of traits. This may be accomplished through line breeding of selected hybrid progeny by means of self-pollination and sib crosses (crosses of sister seedlings) with occasional backcrosses to one or the other parent.

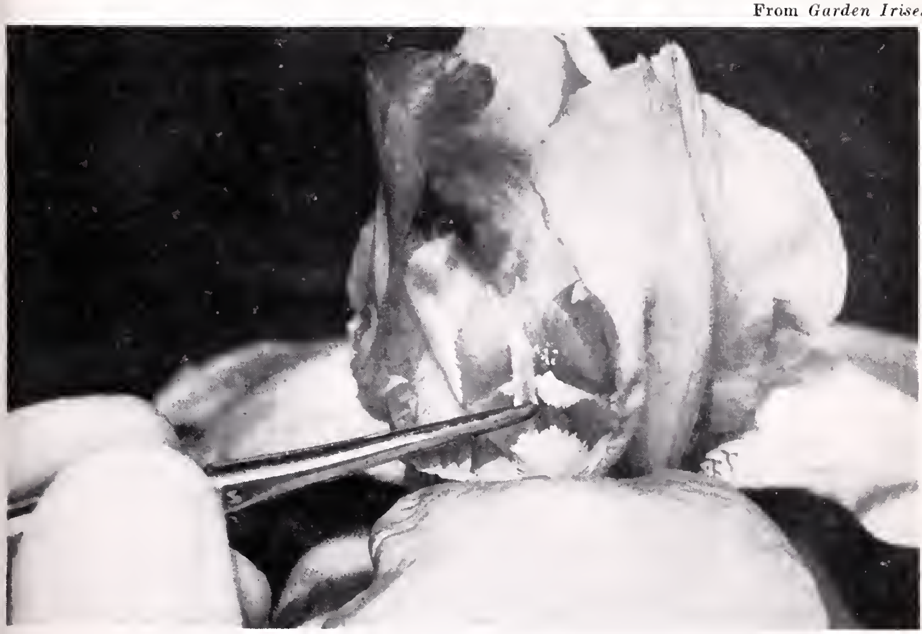
In general, interspecific hybrids may best be achieved between closely related diploid species of the same chromosome number or between tetraploid species. Such hybrids would be expected to be fertile and amenable to improvement through further breeding and selection. Hybrids between distantly related species or between species with different chromosome numbers can often be pro-



Stamens are removed with tweezers, prior to cross-pollinating, to prevent any possible self-fertilization

Artificial pollination is performed by brushing a pollen-shedding stamen held by tweezers against the protruding, lip-like sticky surface of the stigma

From *Garden Irises*



duced but since at best they are usually only partially fertile they are of limited value in breeding.

Flower Structure and Crossing Techniques

It is not difficult to cross iris for in general the flowers are large and the stamens and stigmatic surfaces easily accessible. Methods are described and illustrated in an article by John Dolman, Jr., "The Iris Breeders Objectives," in PLANTS & GARDENS, Spring 1948. Flowers of bulbous iris and beardless species are structurally similar and the techniques for crossing the same.

The structure of the iris flower is such that cross-pollination is the rule and self contamination is rare except in Spuria and Siberian iris. Bees are the chief pollinating agents and if they are active some precaution against contamination is necessary. Care should be taken to use only freshly opened blooms and after pollination the falls should be broken at the base to prevent pollen laden insects landing near the receptive surface of the stigma. In Spuria and Siberian iris it is also advisable to remove the stamens before the flower opens.

The stamen is removed with tweezers and the pollen applied to the upper surface of each of the three stigmas as shown in the accompanying illustrations. If pollen is applied with a camel's hair brush, as sometimes is necessary when stored pollen is used, the brush should be sterilized by dipping in a vial of 50% ethyl alcohol between each different cross. As soon as the flower is pollinated it should be tagged and a full record of the cross made in a notebook. Carefully kept records are invaluable to the breeder.

Storing Pollen

The breeder interested in making wide crosses between forms which bloom at different times may store pollen in the refrigerator at approximately 38°F. For best results anthers from fresh flowers should be selected, placed in glycine envelops or plastic capsules and stored in a container with 50% sulfuric acid, calcium chloride or some other dehydrating agent such as Silica Gel manufactured by Davison Chemical Company, Baltimore 4, Maryland. Pollen so treated will remain viable for weeks or longer. When stored at room temperature in a reasonably dry place iris pollen will remain viable for 1 to 3 weeks.

Harvesting and Care of Seed

Seeds of bearded iris are harvested when they turn brown and the pods split open, usually about 60 days after pollination. At this stage the seed should be removed from the pods and air dried at room temperature. Planted in late fall they will normally germinate the following spring. Somewhat better germination has been reported in Louisiana iris if the seeds are harvested and planted while still green.

Selected References

The Spring 1948 issue of PLANTS & GARDENS contains a number of fine articles on iris in addition to the one on breeding previously mentioned. Anyone seriously interested in breeding iris will find the various publications of the American Iris Society* invaluable sources of information. *Garden Irises*, edited by L. F. Randolph, is an authoritative and comprehensive treatise on all aspects of iris culture, propagation, garden uses, diseases, classification, genetics and breeding. The 1939 Iris Checklist and various supplements published more recently by the American Iris Society list the parentage of all registered and introduced varieties. The Bulletin of the American Iris Society and the publications of its affiliated societies devoted to the improvement and popularization of dwarf, median, aril, Louisiana and Spuria iris provide up-to-date information about iris species and varieties.

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* American Iris Society, 2237 Tower Grove Blvd., St. Louis 10, Mo.

METHODS USED TO PRODUCE NEW COLORS IN IRIS*

David F. Hall

ABOUT 1918, when we visited the lovely iris gardens of Mr. and Mrs. Douglas Pattison in Freeport, Illinois, we were thrilled by the beautiful new varieties on display and decided at once to grow some of these newer, better ones.

A year or two later we visited the Sass brothers' gardens, near Omaha, Nebraska. They were among the leading iris hybridizers in this country at that time. We were astonished at what they were doing to improve the beauty of iris, and upon returning home, made some crosses and harvested quite a few seeds. A couple of years later, when the seedlings bloomed, I was very disappointed and could hardly believe that not one of them was as beautiful as its parents.

At this time we owned half interest in a horse and cattle ranch near Calgary, Alberta. We observed that the very finest stallions and bulls used for breeding rarely produced offspring in the first generation that were outstanding, but when these were bred back to their offspring, the second generation in most cases showed marked improvement.

Cattle Breeding a Guide

I studied the breeding of champion horses and cattle and was impressed with the frequency of inbreeding or line-breeding among these champions. This led me to the conclusion that the laws of heredity that apply to breeding animals also apply, in a large measure, to breeding plants. So I decided to continue my work with iris and apply these same principles.

I noticed that the so-called pink iris all carried some orchid or lavender tones or were blends. I thought a pure pink iris would be popular and to produce one, a worthy challenge. I selected for that purpose four of the nearest pink iris in our garden and line-bred them, selecting for further breeding the best of each generation. One of these four was named 'Aphrodite'; in it the lavender color appeared to be quite dominant, and I found that nearly all of the seedlings also lacked substance and size. Therefore, after working to breed the lavender and orchid out of this family for eight years, I became discouraged and had every one trucked away.

I decided to make another try to prove my theory of line-breeding and selected for this purpose iris of larger size, with better substance and stem, even though they were not as pink as the ones I had been working with.

The five selected were 'Rameses' (Sass), a pink and yellow blend and an American Dykes award winner; 'Dauntless' (Connell), possibly the best red of its day, also an American Dykes award winner; 'W. R. Dykes' (Dykes), one of the first large yellows, an English Dykes award winner; 'Morocco Rose' (Loomis), a pinkish blend; 'Dolly Madison' (Williamson), a pink and yellow blend.

Nine years later in 1942, four pink iris with tangerine beards appeared among my seedlings. Imagine the thrill and satisfaction in achieving this objective after seventeen years of work and growing about 20,000 seedlings!

Two of these four pinks were named and introduced, 'Overture' and a small pink named 'Dream Girl'. Pink seedling No. 42-10 has proven to be the best parent of the four, but it was never

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* Condensed from the Bulletin of the American Iris Society, July, 1958.

named. This was a mistake for it was in my opinion the best flower. I was influenced in naming 'Overture' instead of 42-10 by well-meaning friends who preferred it.

The year the pinks first appeared in my garden I discovered two commercial artists admiring them. I asked these gentlemen to describe the color in language the general public would understand. Half an hour later they reported that they agreed that "Flamingo Pink" was the best name they could offer, and so this strain became known as Hall's Flamingo Pinks.

Line-breeding the Flamingo Strain

I have continued to the present time to line-breed the offspring of these first four pink seedlings with the addition of a large orchid-pink sister seedling that had extra good substances and a fine, well-branched stem. From this strain or family of iris over the past sixteen years has come quite a wide range of attractive colors: baby ribbon to deep-toned pinks, brilliant yellows, whites with tangerine beards, golden apricots, rose tones, and a very attractive line with yellow or pinkish yellow standards with cream falls widely edged with the color of the standards, on the order of 'Palomino' and 'Golden Garland'. Many of this Flamingo strain have tangerine beards, much ruffling, and lacy edges. A very large per cent of the seedlings of this whole wide family have good form, substance, and strong well-branched stems.

Until a few years ago I was anxious for fear this continued line-breeding would result in a loss of vigor, but, on the contrary, today's seedlings are more vigorous and are vastly superior to the early ones in every respect. This is probably due to my practice of selecting for vigor as well as other desirable characteristics when making crosses. I believe line-breeding of this strain can be carried on indefinitely with good results.

In selecting parents, consideration must be given not only to color but to all other characteristics that are necessary to develop a flower and plant of commercial value. I now have several sub-strains or families of these different colors or markings that I am developing.

I have made a few outcrosses but the results have been disappointing. This doesn't prove anything, for I may have exercised poor judgment in selecting varieties for the outcrosses, and furthermore, I haven't made enough of them upon which to base a conclusion. But while I may continue to make an occasional outcross, I will stay close to line-breeding.

Through the years I have grown an average of 1500 iris seedlings annually. To date (1957 inclusive), 81 of my iris originations have been introduced and 55 of these have received one or more awards from the American Iris Society. Forty-four of my hemerocallis originations have been introduced.

David Hall's best seedlings are arranged attractively in his own garden

DAFFODILS—
A REVIEW AND PREVIEW

Wise counsel for those who seek to hybridize daffodils for the U.S.A.

Jan de Graaff

IN the gardens of our South, daffodils of one kind or another grow and flower, from year to year, as they must have done for a very long time. They grow without care or attention. They are picked, their foliage is cut or mowed along with the grass. They are trampled on, dug up and thrown out, only to grow again where they land. Obviously there is an amazing strength in those daffodils.

During the past forty years I have formed many collections of novelties, partly by purchase from all over the world and partly by hybridizing. In my commercial operation, we did not just plant them in a garden setting. They were grown in actual field plantings, to compare their performance, one with another, as to flowering and rate of propagation, bulb type and susceptibility to disease. These collections of daffodils, the cream from some two thousand varieties, changed from year to year as I discarded varieties in favor of better ones. It now holds a mere two hundred varieties. As I weeded it out, balanced it, I tried to keep in mind the ultimate use for these daffodils—the American garden.

During this process of eliminating poor varieties and selecting better ones, I have tried for a selection of the best garden daffodils that represent all types—early and late varieties, whites, yellows and bi-colors, of triandrus and jonquilla hybrids. I did so in the belief that the American public would grow up to appreciate these variations on the daffodil theme. Judging by the growing membership of the American Daffodil Society, the increasing number of daffodil fanciers all over the country, and increasing bulb sales, I can say that there has been some success in this work.

Yet, I have serious doubt that the daffodils the general public is buying today answer their need. Good as the modern daffodil is, it is not good enough.

My objections to these varieties are twofold. One is that they have been bred and selected for show purposes, not for the garden. The other is that this breeding and selecting has gone on in climates totally different from our own. Two influences, then, have controlled the ultimate choice: one is environment, soil and climate; the other is the human factor. For us, in America, both have been wrong.

In order to put all this in its proper perspective, let us review briefly the history of the cultivated daffodil. Apart from the sporadic occurrence of the wild Spanish and Portuguese daffodils, the first cultivated varieties in the Northern Hemisphere were the multi-flowered ones, the polyanthus types and the paperwhite. Four hundred years ago, these polyanthus daffodils, both in single and double forms, were brought first from Constantinople to the south of France and later on, from there to Holland. These daffodils were not then known in the wild. They have, in fact, never been found as wild plants. They were already then *cultivated varieties*. In 1788 one Dutch firm offered as many as 154 varieties. This list includes the old 'Soleil d'Or', still grown today, and several others that can still be found.

Apart from these polyanthus daffodils, there were only a few others offered. 'Sir Watkin', a variety known to most of us, was found in 1868, growing wild on an estate in England. In 1884 the entire stock was sold and the variety named for Sir Watkin Williams Wynn. It is around that time, too, that gardeners

began to show an interest in daffodils other than the polyanthus types. It was in 1874 that Peter Barr drew the attention of a group of prominent growers to the collection of Edward Leeds.

The collection was finally bought by Peter Barr, who retained half and the other half was split between two Dutch firms. Our firm, de Graaff Brothers, was asked to grow the stocks bought by Barr.

Let me give you a few other dates. In 1865 William Backhouse raised 'Emperor', and 'Empress'. In 1887 my grandfather showed 'Madame de Graaff' and 'Glory of Leiden'—the first really high-priced varieties. This renewed interest in daffodils of all types made people search again for old ones. The famous variety 'Golden Spur', was found in 1885 on an estate in Holland. The first popular monograph on daffodils is Burbidge's book that appeared in 1875. The first daffodil conference was sponsored by the Royal Horticultural Society in 1884.

By the turn of the century firms like E. H. Krelage & Son and Warnaar & Company started raising new daffodils. The famous white trumpet variety, 'Mrs. E. H. Krelage', was first shown in 1912, while 'Golden Harvest', the first serious rival of 'King Alfred', was introduced in 1927. 'Unsurpassable', a much better variety, came along in 1929.

Gradually a difference between the Dutch and the British introductions began to show up. I would say that this became evident right after the first World War. This difference showed not only in the type of flowers that were favored, but also in the varieties chosen for mass production. It was essentially the difference between the Dutch breeders, who were thinking of world markets, and the British, who were thinking of the show benches of the R. H. S.

This difference then points to what is essentially the human factor in daffodil breeding and selection. It is a point that has been overlooked but it is far too important to forget.

This human factor enters into daffodil breeding at many stages. First of all there is the selection of the parent stocks from which to breed. That represents taste, a leaning toward certain colors and forms; usually an ideal, however vague it may be. *The day that one could carelessly dust some pollen from one daffodil on the stigma of another, raise the seeds and eventually find a magnificent novelty among the seedlings, is gone. Those careless, happy days disappeared some forty years ago.*

The climate in which the hybridizing is done is of great importance. George Heath mentions in his nice little price list that most of the daffodils now in commerce are raised in a climate unlike anything we experience here in the United States. Those from Ireland are from a latitude of about 55 degrees north, others from Holland only a few degrees farther south. To give them a similar location in this country, they would have to be planted on the shores of James Bay in Eastern Canada, approximately 1,500 miles north of Washington, D. C.

Now this is, of course, correct as far as it goes, but it is not the whole story. The climate of both Ireland and Holland is very much modified by the Gulf Stream and by other factors. The bulbs are raised on the western shores of the ocean, not on the eastern shore. For those reasons the comparison is not valid.

Just the same, it is true that these daffodils are bred and selected in a climate very much different from, let us say, that of Philadelphia or Washington, D. C. By continued breeding with those daffodils, certain characteristics, certain linkages in their genetic make-up are inevitably accentuated. The flowers that stand up well in the weather, that produce the most pollen and the most seed under the conditions of the local micro-climate, will, by reason of sheer preponderance in number, appear more frequently as *parents* in the beds of seedlings. Through the years very definite lines of parentage develop and, through what one might call the road of least resistance, these lines are more and more accentuated.

(*Continued on page* 110)

Hybrid seedling daylilies (*Hemerocallis*) are grown in trays — each cross labelled — by hybridizer William Dill of St. Louis

NOTES ON HYBRIDIZING HEMEROCALLIS

An expert gives thoughtful counsel

Elizabeth Nesmith

DURING the thirty years that I have been growing and hybridizing hemerocallis, it seems almost incredible that such great advancement has been made in the improvement of their color, size, form, branching and general beauty.

To a great extent, I believe in line breeding. As a consequence, I keep careful records of all crosses in my stud book so that when a good new seedling blooms I can look back to its parentage and decide with what to breed it. Therefore, I do not advocate mixed pollen in hybridizing for it would be a lottery trying to decide what to use for further breeding in hopes of producing any particular color. After using my own seedlings in many line crosses, sometimes I use a fine named variety of similar color from another breeder to introduce new blood in order not to do too much in-breeding.

I am intensely interested in trying to produce better pale yellows (near whites), rich velvety oranges, lavenders, dark blue-purples, pinks and clear clean reds. I prefer solid colors or selfs rather than blends or polychromes.

I like large flowers if they have firm enough substance to withstand hot sun and rain, but many huge blooms do not hold up under adverse weather conditions, so I must confess that I prefer those of moderate size (5 to 5½ inches) that have quality with a capital Q, for to me quality is paramount. They should have clear non-fading colors, good texture, smoothly finished flowers well spaced on sturdy well-branched stalks.

To new hybridizers my advice is to select carefully the varieties you cross. Do not make too wide crosses; avoid dull or muddy colors and varieties that have weak flexuous stalks, for such faults are difficult to eradicate from the resulting seedlings. If, on account of lovely color, you are tempted to use one with

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* Condensed from The Hemerocallis Journal, Vol. 12, No. 2, 1958.

McClure photos

Hemerocallis 'Ruth Lehman', pictured here, has fine substance and form, and is being used as one parent in breeding a strain having melon tinted flowers

weak stems, then by all means cross it with one that has exceptionally sturdy stalks.

The method that I have found satisfactory in keeping records of crosses follows. Purchase small green tags (the wasps and hornets do not eat green ones) and mark the number of the cross on each tag. Then in your stud book write down your cross with the pod parent first X the pollen parent. When the seed pod ripens, put it in an open envelope with the number of the cross written on the outside.

Plant seeds early or in October when there is more time. I prefer to plant them in flats in a mixture of good garden loam, well-screened compost, a liberal amount of peat moss with a small amount of bone meal and Milorganite mixed in the soil in the bottom of the flat. Plant each cross in a row with the number of the cross marked with an indelible pencil on a wooden painted tree label that has a copper wire attached. On the outside of the flat drive a strong tack half way in and around this wind the copper wire which will stay in place all winter. Cover the seeds with a scant half inch of soil. I do not find it advisable to peel the seeds for with this method of planting I have almost perfect germination.

Water the flats and put them in a brick-lined coldframe to freeze during the winter. Over each flat tack pieces of wire window screen, for we have found if we do not, moles and mice some way will get in and upset many of our seeds. In early March, put glass over the frame and by late May the seedlings are ready to plant out. Plant the seedlings in rich garden loam in rows with the number of the cross at the head of each cross. It is wise to clip off a little of the tops of the leaves to help counteract the shock of transplanting. If transplanted as early as possible many will bloom next year. If any albino seedlings come up, do not bother to plant them out for they will not survive.

In the morning when the seedlings commence to flower, I like to walk along the beds and note which ones attract my attention, for color, form and substance. Later in the day I make a return trip to see how those I liked at first have stood

Orville Fay, hybridizer, stores seed from ripened daylily pods in labelled cheesecloth bags, hung on a line in enclosed porch

the test of hot sun or rain. Some of the reds will have the red pigment washed off by rain. This is a serious fault. I tag those that are still attractive so that I can watch them through the season. It takes great fortitude to discard rigidly, but it is most necessary unless the seedlings are a step forward in breeding.

I have found it most helpful to have hemerocallis judges and garden visitors that have a critical eye for color mark with tags the seedlings that seem to them to be outstanding, for sometimes in the busy rush of gardening I might overlook a subtle break. These are saved for further observation, but the final decision of introduction rests with me.

A hybridizer should not be in a hurry to name and introduce a new seedling that to him seems perfect. Test it for at least three years. If possible, visit a garden in your vicinity and see many named varieties in bloom, so that you can observe their actual colors and compare your seedling to see if it is really different in color, number of blooms, hardiness and pleasing height.

Although there are always many disappointments in plant breeding, there is no thrill quite equal to seeing a beautifull new seedling of your own unfold and to realize that you have helped to create something new and beautiful for others to enjoy with you.

Hybridizing the Hemerocallis*

Breeding aims and ideals

"My chief aims are to produce better, tall growing, heavy branched stalks, lush green foliage, many blooms of heavy substance remaining open for 24 hours and rich selfs, lovely blends and striking bicolors." (Orville C. Coughlin, 1947.)

"The following ten breeding aims are suggested: (1) earliness, (2) fragrance, (3) petal durability, (4) recurrent blooming, (5) broad petals, (6) new colors, (7) branched scapes, (8) scale relationships, (9) attractive foliage, and (10) vigor." (John W. Watkins, 1950.)

"Enough attention has not been paid to the producing of better evening-blooming hemerocallis. Good varieties to use in breeding for these are 'Sonny', 'Canari' and 'Calypso'." (Elizabeth Nesmith, 1947.)

"We use parent varieties which have one or more of the desired characteristics. In breeding for color, two varieties of the same general color are crossed and the best seedlings selected and interbred until no further improvement is noticed. At the same time new blood is constantly added by crossing these seedlings with another variety of the same general color." (Henry E. Sass, 1947.)

"It is a waste of time to use hybrids produced twenty or thirty years ago as parents since modern growers have exhausted the possibilities of these older clones." (Stanley F. Saxton, 1947.)

"The breeding potential of a hemerocallis cannot be visually determined; the only way to know is from experience in using it." (Harry S. Tuggle, 1953.)

"The everblooming character is more or less recessive. By establishing a line of everbloomers and then following selective breeding, great strides can be made." (Henry E. Sass, 1955.)

Chances of Success

"Out of the first 10,000 seedlings only 0.8% were selected for further study and only 38 were named and introduced." (Dr. H. P. Traub, 1947.)

"Mr. Wheeler estimates that he has grown well over 150,000 seedlings—and yet has named only about 60 plants." (Stanley Saxton, 1948.)

* The above notes are extracted from The Hemerocallis Journal, 1957 Yearbook, American Hemerocallis Society. Dates after the authors' names indicate the date of the Yearbook containing the full text.

HYBRIDIZING AFRICAN VIOLETS

An easy plant on which to learn breeding techniques

Peggie Schulz

HYBRIDIZING saintpaulia (African violets) can be a fascinating hobby, a profit-making venture, or another step into the wonderful world of plant propagation. You can carry on a successful hybridizing program in the window garden, under fluorescent lights or in the greenhouse.

There are thousands of named varieties of African violets on the market but window gardeners and African violet collectors still hope for better doubles in all colors, a wider color range in all types, larger and more flowers on all varieties, better miniatures and interesting new foliage patterns. If any of these factors intrigue you, why not set your hands to creating some new African violets?

It is important to have a definite aim in your hybridizing work for without one you can grow and discard thousands of inferior plants without ever finding one which may be an improvement over existing varieties.

Stated simply and to start you off on the right foot here are the facts you need to know.

On crossing plants with contrasting characters some characters of the two parents are *dominant* whereas others are *recessive*, in the first generation. This is most important for it means that one generation often is not enough to bring out the desired results in plant breeding. Seedlings from the first cross may have to be selfed or crossed with their parents to effect a recombination of parental characteristics and so produce the traits you desire.

Most African violets have bisexual ("perfect") flowers. This means that the flowers have pollen sacs (yellow pouches near center of flower) which represent the male element; the pistil (elongated appendage near the pollen sacs) is the female element. A few double flowers lack pollen sacs and may not have perfect pistils and an occasional single flower may also be lacking in these organs.

The mechanics of pollinating are simple. Choose a sunny day when the pollen is likely to be dry. Use a small scissors or your thumb nail to break open a pollen sac. You can let the pollen drop on a small piece of paper or your finger nail. Then, using your fingertip, a toothpick, or a small brush, apply this pollen to the stigma (tip of pistil). The stigma is ready to receive the pollen when it shows a tiny blob of clear liquid on the tip end. If you aren't too familiar with African violets, use a magnifying glass to guide you.

After a successful pollination, single flowers drop off but the double varieties may remain intact for weeks with the enlarged seed capsule growing right through the center of the flower.

After you have made the cross, write the name of the pollen parent and the date of pollination on a slip of paper or a stationery tag and slip it over the pollinated flower around the stem.

It takes four to nine months for the seed capsules to ripen. You can clip them from the plant as soon as they begin to wither or you can leave them on the plant to finish ripening. Store ripe capsules in a cool dry room.

The seeds are very fine so shell them over a piece of paper. Capsules may contain as few as 2 or 3 seeds or as many as 300 seeds.

Best germination is obtained from freshly harvested seeds but I have had up to 50 per cent germination on year-old seeds.

Keeping Records

It is important to keep records of your work. To do this purchase two small notebooks. The first one will be your "stud" book and will hold information about the crosses you make, date they were made, notes about the success of the cross, and date of seed harvest.

The second book will contain information about the seedlings, when the seeds were planted, when they germinated, when they showed their first flowers, and descriptions of their foliage and flowers.

With these two books as reference you can then check to determine worthwhile parents.

Choosing Parent Plants

When choosing parents for your new hybrids, don't be afraid to "step on the shoulders of those who have gone before you." Go to one of the select violet houses and purchase two to four interesting plants. Most people who sell them are or were hobbyists and they will tell you whether the plants you are purchasing are good "seed setters" or whether they are sterile.

Pollen is gathered by clipping open the pollen sac portion of the stamens with small scissors, letting the pollen fall on a piece of paper

Author photos

It is possible to use the pollen from a blossom and apply it to the stigma of that same flower or another flower on the same plant (self-pollinate) but the offspring from this cross wouldn't be impressive—just more of the same. Far better results come when you cross different varieties.

In African violet jargon, the plants having the light colored patch at the leaf base are called "girl" types; the green leaved ones, "boy" types. This has nothing to do with the sex of the plant but the "girl" trait is a dominant one and when you use one of these plants in a cross you'll get a high per cent of seedlings showing this leaf type.

The gene causing the blue or purple flower color is also dominant so if you cross a purple flower with a pink one don't expect pinks in the first generation. Self the F_1 seedlings and you'll get a good per cent of pink flowers in the second generation (F_2).

With most African violets it won't matter which plant you choose as seed parent except in the case of variegated varieties. If you are working for these fancy leaves use a variegated one as a seed parent, for variegation is transmitted through the maternal line only.

Crosses Between Species

There are about 12 species of African violets on the market and while they are interesting they are not nearly as beautiful as the improved hybrid types.

It is possible to make crosses between the species but to date few offspring have had commercial value. I have one that I think would be of value and if you would like to try the same cross here are the data: *Saintpaulia confusa (diplotricha)* x *S. tongwensis.* The seedlings were intermediate between the two species, having the thinner foliage of *confusa,* the wavy pointed leaves of *tongwensis.* It is a free bloomer having small purple flowers. The plants are neat growers with flexible foliage—an important point for commercial growers who find such plants easy to pack and ship. Further crosses between this hybrid and some of the

This year-old seedling sets seeds abundantly and has numerous other good qualities. It is being used as a parent for further hybridizing in preference to some named varieties

double-flowered or fringed-flowered hybrids should produce interesting progeny.

When the trailing species *S. grotei* was introduced, collectors visualized a race of interesting hybrids having this one as an ancestor. Although thousands of such crosses have been made, few good commercial varieties have resulted from them. 'Shine Boy', 'Trailer', and 'Blue Cluster', are some of the most popular. An interesting new one, 'Hollywood Ace', was obtained by using colchicine on a cutting of 'Blue Cluster' to produce one of the "supreme" or thick-petioled varieties.

Most species cross freely with hybrids but the seedlings are usually inferior to either parent. However, the seed crop is heavy and the seeds fertile.

About a Yellow

To date there has been no yellow African violet. There is a variety originating on the West Coast, 'Lemon Drop', which seems to have a bit of yellow in its center but breeders have told me that it does not impart this yellow to its offspring.

A few breeders think we will get a yellow by making crosses between African violets and some of their yellow-flowered gesneroid relatives. I have made hundreds of such crosses but when a seed capsule did form it was parthenogenetic, that is, the seeds developed without fertilization having occurred. This happens upon occasion. The seedlings looked like the seed parent.

Most breeders are of the opinion that a yellow will come about as a sport or mutant—a true change in one part of a plant.

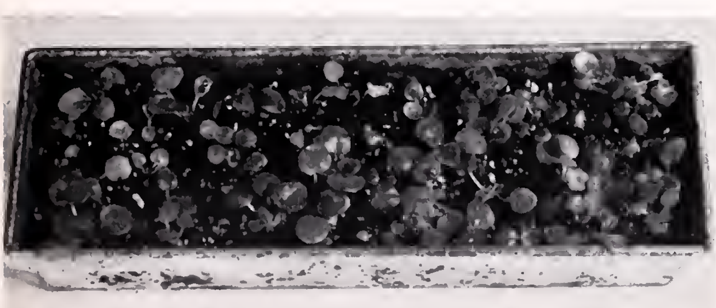
Current Favorites

High on the fashion list are the violets with the chartreuse petal edges—and of course pink is always a favorite. If you are interested in breeding for these traits use as one parent 'Vallin Pink'. This single-flowered variety has fringed petals and chartreuse edges. Try it on 'Northern Fantasy', 'Fandango', or 'Double Fantasy'.

The old reliables 'Neptune' and 'Double Neptune' are still good to incorporate into breeding lines.

If you like wavy leaves try some of Robert Anderson's Hi-Loa series or the wavy-leaved Fischer varieties.

My variety 'Ruffled Triumph' also



Metal or plastic trays, preferably with drainage holes in the bottom, are ideal for raising seedlings

transmits the elegant ruffled foliage to its offspring.

The bright fuchsia coloring is rather new in violets and although fuchsia-colored violets are not good seed setters you can get some of them to set an occasional capsule. From this capsule, though it may contain only a few seeds, can come the start of a line of fuchsia-colored violets. Lyndon Lyon's 'Racy Red' makes a good parent.

Dr. Sheldon Reed, St. Paul, Minnesota, who has given us so many marvelous new hybrids, believes it is possible to obtain some extremely interesting foliage varieties from 'Clackamas Rattler'. Seedlings having this for one parent show dark longitudinal veins. They resemble striped-leaved peperomias.

The seed pod on an African violet is ripe when it begins to soften or turn mushy. It can be left on the plant to dry, or clipped and stored in a cool dry place.

Within the capsule are several small brown or black seeds. The color and number of seeds varies with the variety.

When seeds must be stored for some time, shell them out and place them in a covered container. An aspirin bottle is fine. Add a few grains of silica gel, a chemical that absorbs moisture.

Sow the seed on moistened beds of chopped or shredded sphagnum moss, vermiculite, sponge rock, or a mixture of all these components.

Keep the medium moist and in the dark. Seeds sprout in ten days to two weeks but it may take much longer—up to three months—for a few late ones to appear.

As soon as tiny green flecks dot the surface, place the container in the light. Do not set these small seedlings in direct sunlight, rather place them where they receive light minus strong sun. Fluorescent light is fine for them, as is the shaded greenhouse. Be sure these tiny violets are kept moistened. If you are afraid of disturbing them, water with a teaspoon or an eye dropper.

When leaves touch one another (about a month under good growing conditions), it is time to prick them out and plant into thumb pots or community pots. Use a pencil or any other small "tool" to loosen and lift them for transplanting into sterilized soil having good drainage.

Under optimum conditions, i.e., perfect light, moisture and temperature, seedlings will flower in four to six months. The first flowering will be sparse but it still gives an accurate idea of the color and contour of the flower and the shape of the leaves.

After a few years breeding violets or any other flower, one can soon learn which are the "keepers" (plants worth keeping for further breeding purposes) and which are the rogues. The first feeling is, of course, that all the geese you raise are swans but you have only to visit an African violet specialty house and you will know that out of hundreds of plants you raise, only a few are good enough to keep for further experimenting.

In a group of seedlings grown from 'Ruffled Triumph', all the plants had wavy leaves, indimating that this character is dominant

HYBRIDIZATION OF ORCHIDS

Amateurs not encouraged

Carl L. Withner

ORCHID hybridization records have been kept from the beginning, and it is possible to trace back the pedigree of almost any present-day hybrid plant in such reference books as "Sanders' Complete List of Orchid Hybrids." Over 10,000 *primary* orchid hybrids have been registered since the first were flowered a little over 100 years ago. There are over 5,000 recorded complex hybrids among the members of just one group alone—cattleya orchids.

Despite these numbers, however, breeding orchids is not easy and is a job for only the most advanced amateur or the professional grower. It requires better than average skill and talent, greenhouse facilities, and high quality stud plants, sometimes worth several hundred dollars, to make the venture worth while. Since orchids grow slowly from seed to flowering size and require much individual care, one does not undertake to raise a crop of plants from seed without learning in advance what is likely to result from a particular hybrid combination. Articles in the publications of the American Orchid Society, orchid show records, and books on orchids are helpful here.

To raise orchids from seed, special techniques are required to germinate the seed. The seedlings must be grown on sterile agar cultures for at least a year before they are large enough to pot out in the greenhouse. Consider, too, that it takes from 12 to 15 months for an orchid seed pod to ripen, and you will understand that hybridizing orchids is a task for the experienced specialist.

This does not mean that the amateur must do without orchid hybrids. Commercial orchid growers with stocks of fine stud plants usually do the hybridizing and sell the seedlings either as young plants in pots, or mature plants that have flowered after anywhere from five to ten years have elapsed. By looking over the catalogue lists of various commercial growers of orchids, hybrids of any orchid group, to suit any taste or pocket, may be selected and purchased. The amateur, in this case, is somewhat of a gambler—hoping to purchase the seedling that will grow to produce a prize-winning plant of American Orchid Society award quality. The chance that this may happen depends of course upon the cross under consideration; it might be one in ten, or one in a hundred. By buying a series of seedlings over the years, even though they are more difficult to grow than mature plants, one can always have something new coming into flower, and can continue to hope for stud-quality plants.

At any rate, for a modest investment, the amateur can possess and bring into bloom plants bred from some of the world's best orchids without investing in stud plants, raising the hybrids from seed, or growing more than a handful of plants in a little greenhouse.

Orchid seedlings are grown in sterilized flasks on an agar culture medium. Seedlings are visible in the bottom of the flasks

Frese

DAFFODIL BREEDING

And particularly as needed in the U.S.A.

Grant E. Mitsch

THERE are literally thousands of individuals, both amateur and commercial, engaged in breeding many of the more familiar bulbous plants, but relatively few are hybridizing daffodils in the the U.S.A. The prime reasons are doubtless the time involved, and a lack of organized interest in growing and showing the blooms. The latter deterrent is being remedied by the formation of national and regional societies devoted to popularizing the daffodil, but little can be done to shorten the interval of four to six years from seed to the first bloom, or hasten the process of accumulating a fair stock of a selected clone once it has been developed.

The genus *Narcissus* (and all its members will be referred to as daffodils here) offers a wide field to those interested in improving it and adapting it to American growing conditions. Most daffodil breeders are in Great Britain and Holland, with a number in Australia and New Zealand. There is a need for daffodils developed for the American climate. The British breeders have laid great emphasis on flowers for exhibition, while the Dutch have developed forcing varieties. We need varieties adapted to our less favorable climate, that are good enough for exhibition and that will tolerate garden conditions. Greater variation in form and color is needed. Brighter, fade-resistant reds, deeper pinks, whites of exhibition caliber with strong constitutions, and more vigorous bicolors should be developed.

Daffodils are not difficult to hybridize, but large quantities of seed cannot be obtained from a few plants as with the gladiolus or bearded iris, for example. The mechanics of crossing are simple. Tweezers are preferable to a brush for transferring pollen from one flower to another. Usually the pollen is ready a few hours after the flower opens, and the stigma is usually receptive nearly as soon. In favorable weather, daffodils may be pollinated as late as ten days after opening, but the chance of securing seed is small if the weather is hot, dry, or windy. Pollinating when the flower is fresh is preferable, but in wet weather, delay may be preferable or even mandatory. From mid-morning until a little past noon is perhaps the most desirable time for pollinating.

Seeds ripen in five to eight weeks and should be collected as soon as the old flower separates readily from the seed capsule, as the seeds shatter readily after the pods crack open. They may be sown immediately or kept until fall, preferably not later than September as later-sown seed may lie dormant until the second spring after sowing. The seeds are planted in boxes or coldframes, and covered 1 to 1½ inches deep with loose friable soil. If germination is early, the seed bed should be protected with sash or mulch until hard freezing is past. After two years' growth, the seedling bulbs are dug and replanted 2 or 3 inches apart, and 3 inches deep. They may be left to bloom here or be replanted about an inch deeper after their fourth year. Some should bloom in their fourth year but most take longer. Selections may be made as the seedlings bloom but ordinarily the flowers are not as large the first season as they will be later.

In any breeding program the choice of parents is important, but it is doubly so with daffodils because of the time involved in growing them. Judicious selection of parents can save years of wasted effort, to say nothing of disappointment.

Obviously, there will be failures, and one must make some crosses purely on an experimental basis for the sake of gaining experience, for no amount of advice can take the place of experience, and no individual will desire to duplicate exactly what some other breeder is doing.

The parents should have beauty of color and form, good substance, strong stems, and vigor. The last characteristic is very important. The first impulse may be to cross the two most beautiful flowers regardless of their growing habits, but these varieties may have serious faults which will be retained or become more pronounced in their progeny. They should be crossed with other varieties having the characteristics which they lack.

Generally speaking, whites should be crossed with whites, pinks with pinks, etc., but an occasional mating of two widely divergent types is desirable. The first method is to improve forms and colors now available, the latter is to get new breaks. While already worked some, a promising field is the crossing of species with modern garden hybrids. Modern varieties are all descended from the wild species. The intercrossing of hybrids for several generations has produced the beautiful garden varieties of today. By crossing with the species we can incorporate the fine colors and form of today's giant show flowers with the delightful grace of the original species.

Certainly no other flower is more fascinating for the hybridizer, and with the few American hybridizers now at work, there is room for many more!

LILY BREEDING

George L. Slate

MOST of the breeding work with lilies has been done since the year 1910. The introduction of new clones and seedling strains has been especially heavy during the last 15 years. Unlike many other garden plants that are easily propagated vegetatively, lilies are being grown and distributed widely as seedling strains in which some attempt is made, by selecting similar types or by appropriate breeding techniques, to provide a reasonably uniform group of plants under a strain name.

Professional breeders have definite objectives, such as vigor of plant, ease of propagation, arrangement of the flowers in the inflorescence, variation in time of bloom and form and color of flower. The "pollen daubers" with limited experience throw pollen around without much planning, take what comes, and are happy. Sometimes they are very lucky. As they gain in experience, their objectives become more sharply defined and they strive for pink or yellow trumpets, pink auratums, hardy whites for the Great Plains and many other objectives. The mixing of many species and the great diversity of types in a hybrid population several generations removed from the original ancestral species help to make lily breeding an exciting pastime.

Several diseases complicate lily growing, but they may be circumvented in part by making use of what we know about them. Some species are disease-tolerant and others are rarely infected. Many lilies can be grown without worrying much about disease, and breeders have as a major objective adding to their number each year.

Planning a Breeding Program

One should know something about the botanical and geographical relationships of lily species to plan the crosses intelli-

When an 'Olympic' strain lily (left) is crossed with *Lilium henryi* (center) the result is an 'Aurelian' hybrid of the 'Sunburst' type (right)

Oregon Bulb Farms

gently. The promiscuous mating of whatever species are in bloom at the same time will not get one very far in a breeding program. One should arrange the lilies of the world according to their botanical relationships and also according to their native homes. Those that are closely related botanically and geographically will cross much more readily with each other. This information can be found in lily books. The classification of lilies by Comber in the Lily Yearbook of the Royal Horticultural Society for 1949 is very helpful. A properly planned program will be much more rewarding over the years than hit or miss crossing.

A knowledge of lily chromosomes is not necessary. All are diploids except a triploid form of the Tiger lily and a few man-made tetraploids. Most lilies are self-incompatible, that is, they do not set seeds when self-pollinated. Very few seeds will be produced by lilies not hand-pollinated unless there is a mixture of closely related clones near each other. One can save a lot of time by not having to protect the flowers from contamination by unwanted pollen. However, if one wishes to be sure of the cross then the flower should be protected by bagging.

Lilies fall into natural groups according to their geographical and botanical relationships. Breeders over the years have discovered which species will cross with each other and most of the systematic breeding is being done within these groups. The beginner will operate most efficiently and with the greatest chance of success if he also works within these groups. The suggestions offered here for the beginner are based on these groups.

The Aurelian Lilies

The Aurelians, as lily growers call them, are based on *L. henryi* and the trumpet species *L. sargentiae* and *L. sulphureum*. Possibly *L. regale* and *L. leucanthum* may have been used by some breeders. These lilies are all of easy culture and very virus tolerant. Basal rot rarely bothers them and botrytis is not serious. Their weakness is susceptibility to spring frost, but by following the weather forecasts and covering the seedlings when frost is predicted one can eliminate this hazard.

The best Aurelians are several generations removed from their original species ancestors and the beginner should start with the most recently introduced varieties. Named clones as well as seedling strains are available. Several different types should be bought and crossed with each other. After a few hundred seedlings have been flowered and others have been seen in gardens and at shows the breeder is in business and can proceed under his own steam.

The Aurelians are first choice for the beginning breeder. They are easy to

grow, spectacular, and bloom in midsummer when color in the garden is scarce.

The Trumpet Lily Group

The trumpet lilies, *L. regale, L. sargentiae, L. sulphureum* and *L. leucanthum,* have all been combined in various ways for several generations by breeders. Numerous seedling strains and some named clones have been introduced. Some of these are very spectacular when well-grown. Selection has been in various directions, but yellow trumpets and pink trumpets are attracting much attention now. The deep pink color of some of these lilies, when grown in Oregon, is lighter and may fade out almost completely in the summer sun of the eastern U. S. Flowers of some seedlings are a dark reddish color on the outside of the petal segments, and are very attractive.

Many of the seedlings have poor flower placement. The pyramidal flower cluster of a well-grown Creelman lily should be sought.

The plants are mostly virus tolerant and apparently resistant to basal rot. Like the Aurelians they are easily injured by spring frosts. Plants that come up a week or two later than the general run of seedlings would be very useful in frosty areas.

The amateur breeder can soon have a fine display of trumpet lilies if he decides to work with them.

The Martagon-Hansoni Group

L. hansoni and *L. martagon* and its varieties, *album* and *cattaniae* are the starting point. It is probably a waste of time to attempt to cross other species

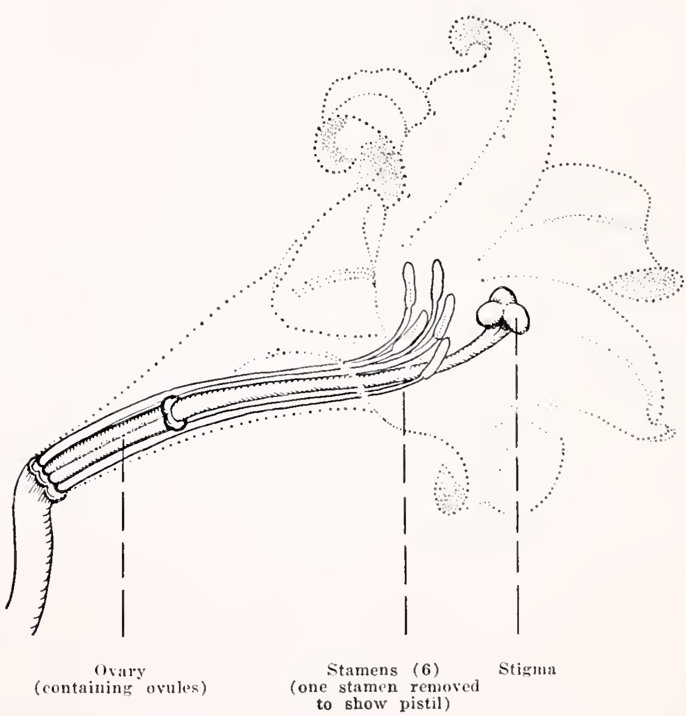


Diagram of the lily flower, with trumpet-like petal portion removed to show parts involved in the breeding process

with this group. Many hybrids involving these species have been raised, but many of them have disappeared. 'Mrs. O. R. Backhouse' and 'Brocade' have been around a long time and should be used as parents in a breeding program.

The better seedlings are very fine and distinct and well worth growing. This group rarely becomes infected with virus disease, but many are susceptible to basal rot (fusarium), especially south of the northern tier of states where the summers are long and hot. Seed germination is poor and many seedlings are not attractive enough to save. They vary greatly in the time required to reach blooming size. Rather large numbers of seedlings should be raised.

In soils with a high pH many will have chlorotic foliage like *L. hansoni*, but others will be as green as the Martagon ancestors. The seedlings should be grown in soil that has not previously grown lilies to minimize losses from basal rot.

The flower cluster of many lilies in this group is short and compact like that of *L. hansoni*. The breeder should seek the long inflorescence of the martagons which is much more graceful.

The Auratum-Speciosum-Japonicum Rubellum Group

These are all beauties and breeders are working them like mad. *L. auratum* and *L. speciosum* were the first to be crossed. The earlier hybrids all died from disease, but now they are being produced in large numbers and are likely to stay with us. *L. speciosum* may contribute some of its persistence in gardens to this group.

L. auratum is susceptible to mosaic virus and basal rot but *L. speciosum* is virus tolerant and apparently resistant to basal rot. One should plan to keep lots of seedlings coming along.

Either species is variable enough to keep a breeder interested for a long time. Together they offer a real opportunity for a wide range of interesting and very beautiful lilies.

The crossing of *L. auratum* with the pink *L. japonicum* and *L. rubellum* has produced some hybrids of extraordinary beauty that should be exploited by the breeder. One must expect that their susceptibility to disease will try his patience, but the breeder will be well rewarded if he can produce the hybrids that this group is capable of producing and make them available in quantity.

The Willmottiae-Tigrinum, Hollandicum Group

This is a large and varied group ranging in color from deep red through orange to pale yellow with nodding, side facing, and upright flowers. Suceptibility to basal rot and virus tolerance undoubtedly vary among the different clones but it is likely that there is considerable resistance within the group. The incorporation of *L. cernuum* has produced some interesting color breaks. All things considered this large and diverse group is a good one for the beginner. The program should start with the best of the hybrids already available.

Bellingham Hybrids

The Bellingham Hybrids produced by interbreeding the West Coast species are an interesting and useful lot as they bloom in early July when there are fewer lilies than earlier or later. Most of the available types originated on the West Coast and while they perform well for two or three years in the East they are not long-lived. The yellows especially are very fine through shorter-lived than the red and orange types. This group should be reworked for several generations under eastern conditions to produce longer-lived varieties.

The comprehensive catalogues of the Oregon Bulb Farms, Gresham, Oregon and Sandy Best, Georgetown, Ontario, Canada will give one a pretty good idea as to what is available to the breeder in new lily clones and seedling strains.

THE BREEDING OF GARDEN ROSES

Dennison Morey

THERE are certain directions in which significant improvements in garden roses might be made. Among these are summer and winter hardiness, disease and insect resistance, and to a lesser extent refinement of character of the plant and flower.

If one should examine modern roses against the background of those of 100 years ago, one would quickly see that tremendous strides have already been made in improving garden roses. However, instead of increasing hardiness or disease and insect resistance, the trend has been toward producing everblooming roses of many exquisite shapes, sizes and colors. Specific objectives now to be sought must be improved hardiness and increased pest resistance, especially to mildew, blackspot, rust, mites and thrips. There is every reason to expect considerable success in reaching these objectives.

Only twelve of more than 300 species of roses known to exist have been used in the production of all our garden roses. This leaves a tremendous host of possibilities for examination (see page 55 for more data). However, the use of species is a long-range project and more immediate gains probably can be realized by back-crossing to the best of the older varieties in which species "blood" is evident.

This procedure is not always possible. Whereas most garden roses are tetraploid with 28 chromosomes, many others, to which back-crossing with tetraploids would be desirable, are diploid. However, crossing diploid and tetraploid roses almost invariably results in triploids which are, because of their sterility, exceedingly difficult to use. Already, many valuable triploid roses exist which would be important in hybridizing were it not for their high degree of sterility. Even so, triploid roses may produce some viable pollen, and they have been bred successfully.

A specific breeding program to consider would be back-crossing modern hybrid teas and floribundas to older varieties known to be resistant or immune to certain diseases. For that matter, there is much variation in the susceptibility of modern varieties to mildew and other diseases. It is almost certain that a high level of mildew resistance will be obtained in most future rose varieties.

Unfortunately, in breeding for resistance, using older varieties, the elegance of the modern parent most likely will be lost in its F_1 progeny. Consequently, a long, tedious program of intercrossing of the derivatives becomes necessary in order to recombine all the desirable characteristics with the disease resistance which is being sought. Moreover, it often develops that while a variety is resistant to mildew or blackspot, it is highly susceptible to rust. For example, back-crossing modern varieties to old hybrid perpetuals that are highly resistant to mildew or blackspot should be a very useful technique. Unfortunately, in areas where rust is important, as on the West Coast, most of these old varieties are highly susceptible to rust even though they are highly resistant to mildew or blackspot. On that account, they lose their significance in hybridizing, since rust, where it occurs, usually is far more serious than either mildew or blackspot.

Further complications are also encountered because inbreeding soon results in loss of vigor and an increase in sterility of the seedlings. Within several generations, an inbred line often becomes practically useless. Therefore, it becomes necessary to deal, in one's breeding work, with a highly heterogeneous situation and on this account, the use of Mendelian laws in the development of a rose breeding program becomes exceedingly difficult.

The practical solution to this problem is a breeding program utilizing a limited

number of parents and workable progeny sizes for each cross so that the transmission potentials of each of the parents can be observed. After observing a series of crosses, it soon becomes apparent which characteristics are being regularly transmitted from this particular parent to its progeny. Once the transmission potential of a variety has been determined and a series of varieties have been analysed, the complementary breeding of varieties with known transmission potentials will usually result in progenies of value. It has been my observation that all of the really successful breeding programs have been based upon this technique in one form or another.

In the initial stages of hybridizing a group of plant materials where Mendelian principles of heredity are inapplicable, a detailed knowledge of the varieties and the characteristics considered desirable are, of course, paramount. If these are known, then complementary crossing of varieties will naturally be done in the initial stages. However, this can be a very misleading technique since many varieties which appear to be complementary phenotypically are not so genetically and do not produce the desired result even when the transmission potentials have apparently been determined.

In designing a program to deal with the basic problems outlined above, modern varieties deficient in hardiness or disease resistance can be crossed with varieties possessing these desired characteristics. Seedlings showing the maximum development of the desired characteristic will probably be deficient in other respects, and intercrossing and back-crossing to the modern parent will be necessary. These procedures often must be continued for many, many generations. However, rather successful results can usually be realized in three or four generations which, in the case of roses, means approximately 16 to 20 years.

As for choosing the seedlings upon which to extend one's program, it would be impossible to define characteristics upon which to base the selection of seedlings. This is something which can only be learned by experience, and it would be a waste of time and useless to try to outline such a procedure here.

The actual hybridization of roses is simple. Roses have perfect flowers; that is, they possess both male and female organs in the same flower. The easiest method of preparation is to open the flower artificially before it reaches full maturity. The petals are usually easily removed once the sepals have reflexed and the bud has begun to loosen. Once the petals are removed, the unopened anthers may be easily removed from the disk surrounding the styles and stigmas and processed by permitting them to dry on a sheet of paper until they open. The dried anthers and pollen may then be placed in a vial from which the pollen may be removed and applied to the stigmas of the seed parent. Stigmas of roses are receptive over a rather long period, and pollen may be applied immediately after the flowers have been emas-

Professional rose breeders must store many different samples of pollen, as Eugene Boerner, well-known plant breeder, is doing here
Jackson & Perkins

culated and up to as much as two weeks afterwards. To facilitate hybridizing, dry pollen may often be stored in tightly closed jars or vials and held at temperatures of from 34 to 40 degrees F. Certain pollens are very short lived, others very long lived, but for the most part, rose pollen may be held from one month to a year without any difficulty.

It takes from 90 to 120 days for seeds to mature. As soon as the fruits begin to show color, either russet, orange, or red, the hips may be harvested and the seeds removed from the pulp and planted, as soon as possible, in a 50/50 mixture of ground sphagnum and sand, or peat moss and sand. The medium should be kept moist and the seeds and their medium kept in a warm greenhouse for six to eight weeks. Seeds that have matured under high temperatures normally will germinate quite readily within this time without stratification. However, stratification is usually desirable and will often increase germination even though the initial germination was good. After the first germination has been pricked off, the flats of remaining seeds should be stratified for at least 90 days at temperatures of approximately 35° F. This will usually induce very satisfactory germination in recalcitrant seed lots and will improve the germination in those seed lots that have proven fairly successful already. A second and third stratification has sometimes proven useful, especially where small amounts of seed are produced.

The seedlings should be pricked off as soon as two, three-parted leaves have been produced and put into 2-inch pots. In my own operation, I prefer the peat pot because no shifting is necessary and the shock of transplanting into the field is much reduced. In warmer areas, seedlings can be grown for several years in the field to determine their value, during which time the best can be selected and propagated. In colder areas, it is often necessary to shift the seedlings several times until they have attained such size that their growth characteristic and value as an ornamental is indicated. More details on technique can be found in almost any book on rose growing, particularly R. C. Allen's "Roses for Every Garden."

Because of the complexities of polyploidy, there is a dearth of information on the actual inheritance of characteristics in roses. However, some work has been done and much of this has been reported in various journals including the publications of the American Rose Society.

One of the most useful books for the rose breeder is "Modern Roses V" which lists the reputed parentages for thousands of varieties of roses. By tracing the lineage of a certain rose, it is often possible to determine its transmission potential to a degree. This can often save considerable time.

In conclusion I feel obliged to point out that the hybridization of roses, while simple mechanically, is genetically complex. The expectation of success is about one in 20,000 seedlings, plus ten years for the development of the successful variety prior to its introduction to the public. For the amateur, luck plays an important role. Regardless of these facts, the personal satisfaction to be had in producing one's own new rose varieties is certainly great and there is always a hearty welcome for the elect. But always remember that while "many are called, few are chosen."

Shredded sphagnum moss is one of the best mediums in which to sow rose seed. The rows are planted from left to right, and the labels are placed at the beginning of each batch of seed in the row

Jackson & Perkins

THE NEW GRANDIFLORA CLASS OF ROSE

Origin of this important new group

Walter E. Lammerts

DURING recent years, rose hybridizers' efforts to combine the abundant flowering habit and rugged garden adaptability of floribundas with buds and flowers of hybrid tea size, form and quality, has led to much confusion as to the exact classification of varieties resulting from such crosses. The situation is, in many respects, similar to that which existed in the early 1930's when many floribundas were first introduced. At that time, low- and even tall-growing, small-flowered cluster varieties were classed as either polyanthas or hybrid polyanthas.

Orginally the term hybrid polyantha was set up as a class name for the small-flowered, low-growing, cluster-blooming hybrids resulting from crosses between *R. polyantha* and *R. chinensis*. For a while this terminology was clear-cut but became confused when crossing of these hybrid polyanthas with hybrid teas began.

Birth of "Floribundas"

Finally, in 1935, E. L. D. Seymour suggested to Dr. Nicolas and Charles Perkins that these new hybrids, such as 'Rochester' and 'Smiles', developed by Nicolas, and 'Baby Chateau', originated by Wilhelm Kordes, be called "Floribundas". The excellent descriptive nature of this term took hold immediately from the catalogue point of view and the new varieties developed later, such as 'Pinocchio', 'Fashion', 'Vogue' and 'Floradora', were catalogued and described under this new class name.

Back in 1940, when writing for the Pacific Rose Society invitational spring issue, I wrote, "one of my objectives is the development of a class of roses having disease-resistant foliage on a symmetrical bush, quantities of flowers borne singly on stems long enough for cutting and buds comparable in form to those of greenhouse-grown roses. Such a rose should "break" readily so that the hostess will be assured of plenty of flowers for small vases and other arrangements. Aside from these decorative uses, the bush itself should possess decided ornamental value because of its symmetry and large glossy foliage."

With the introduction of 'Floradora' in 1943, I recognized that here was an opportunity to begin the realization of this objective. 'Floradora' particularly impressed me as being a good rose for crossbreeding purposes because of the unusual interspecific nature of its parentage. One of its parents, 'Baby Chateau', is a cross of a hybrid tea, 'Aroma', with a seedling obtained by crossing the low climber, 'Eva', with the hybrid tea, 'Amy Quinard'. 'Floradora' is rampantly vigorous and has wonderful glossy foliage and at the time was most unusual because of its genetically recessive red color commonly known as geranium-red. Another likely parent was 'Charlotte Armstrong', introduced in 1940, which in itself is an unusually vigorous hybrid, an expression of the phenomenon of hybrid vigor resulting from the crossing of the relatively inbred yellow and red rose lines.

So, to get the super vigor needed for production of the many flowers desired in this new class, even under the most adverse garden conditions, I crossed 'Floradora' as pollen parent onto 'Charlotte Armstrong' in the spring of 1946.

Frankly, I had hoped to get a terra cotta or geranium-red rose intermediate in size of flower with the bud form of 'Charlotte Armstrong'. Instead, early one cool morning in the fall of 1948 I was delighted by the beauty of a sort of subtly fragrant clear coral-pink rose, the first to open of dozens of buds on a superlatively vigorous, glossy-leaved bush. The car-

mine buds, too, were excellent in form, smaller but of the same long pointed type as 'Charlotte Armstrong'. Now known as 'Queen Elizabeth', it has proven to be especially popular mostly because it grows even without trying and, though not immune to such diseases as rust, mildew or blackspot, it is resistant enough to get along with little and sometimes no spraying at all. The All-America Rose Selections group decided that here was a rose fully worthy of an award but that it was definitely neither a floribunda nor a hybrid tea. Al Morris of Germain's suggested the name for this new class as "Grandiflora" since the flowers were larger than is typical of most floribundas and the plants, because of their hybrid tea vigor, are more on the "grand" type, tending to be taller and more robust in growth than any known hybrid tea. This name was then adapted on January 11, 1954, for a variety of rose characterized as follows:

1. Plants of relatively tall growth habit
2. Plants very free flowering, many flowers borne singly on long cutting stems but having many flowers in clusters with individual stems, even when in clusters, long enough for cutting
3. Flower size not necessarily as large as hybrid teas but definitely larger than the average floribunda
4. Hybrid tea standards for bud and flower form.

In defining this class, as with floribundas, habit of growth and performance with regard to the above distinctive features, rather than parentage are to be the criteria for placing varieties in this new grandiflora class. As mentioned above, 'Queen Elizabeth' was the first AARS winner in this class. 'Starfire', a 1958-59 grandiflora introduction, resulted from crossing a vivid red sister seedling of 'Queen Elizabeth' back to 'Charlotte Armstrong'. Though somewhat lower in height, it also is characteristized by having many flowers borne singly on long cutting stems. The most unusual characteristic, however, of this rose is its relatively non-fading fluorescent red color. Another very successful grandiflora is 'Carrousel', a dark red, very vigorous, tall-growing, compact variety introduced in 1950 by Elmer Roses. Relatively unknown but worthy of far greater distribution is the variety 'Merry Widow', similar in its tall compact habit to 'Queen Elizabeth' and 'Carrousel' and having unusually lovely, urn-shaped, high-centered buds and opening to vivid velvety red flowers, similar in color to 'Chrysler Imperial'. 'Buccaneer' is classed by most rosarians as a grandiflora also, though originally introduced as a pillar rose. It produces an abundance of large, clear yellow flowers.

Rose breeders of America are busily at work endeavoring to develop grandiflora varieties of even more exquisite bud and flower form, fragrance and general garden hardiness so that eventually there will be available a complete range of color in these unusually vigorous, tall-growing roses. These, then, in the ideal rose planting, can be used as background varieties behind hybrid teas and floribundas, and in front of either pillar or climbing roses.

'Queen Elizabeth', originated by Dr. Lammerts, has clear pink flowers and exceptionally vigorous plants

Germain's

SPECIES ROSES IN ROSE BREEDING

Only completely new parentage promises to give new types of roses

Roy E. Shepherd

IT is becoming increasingly apparent that rose breeders must add roses of other types, such as the species, to the "blood" stream of our modern roses if they are to make a pronounced improvement in their hybrids. Even the most ardent rosarian will readily admit that none of our present-day roses possess all the qualities we desire: heavy and continuous production of well-formed, fragrant blossoms of a rich color; good habit of growth; disease resistance; and dependable hardiness without protection in all sections of our country.

Each of these characteristics exists in one or more known roses but, as yet, they are not all combined in any one variety. Seemingly their combination is possible and this is the goal toward which hybridists should strive.

The majority of hybridists today appear to lack the pioneering spirit of earlier rose breeders and give every evidence of "working in circles." Before long they may have reached the point from which they began.

In their search for free-flowering, semi-hardy, cluster-flowered types of roses, breeders years ago wisely crossed members of the polyantha rose group with hybrid teas. This line of breeding created the floribundas which, as a whole, are more free-flowering and hardier than most hybrid teas but lack the individual blossom beauty of the latter group. Also, the inherent hardiness and cluster-flowering tendency of the polyantha was reduced.

However, floribundas, as a class, were a fine addition to the rose family, and it seemed that they might become even more desirable if their blossom form were improved. This was accomplished by recrossing the fertile members of the class with hybrid teas. Of course, this resulted in a further dilution of the polyantha characteristics. Several of the progeny of this second infusion of hybrid tea blood were so intermediate in type that it became increasingly difficult to determine whether they should be classed as floribundas or hybrid teas. Still in search of improved blossom form and assuming that the hybrid tea family provided the best available source of the required ingredients, hybridists proceeded to again combine floribundas and hybrid teas and the so-termed grandiflora class came into being. Anyone who has analyzed the characteristics of the latter group will realize that, with the possible exception of increased vigor (credited to heterosis or hybrid vigor), the present members of this class differ but little from hybrid teas. In other words, the repeated use of hybrid teas as one parent in this line of breeding has resulted in the almost entire elimination of the polyantha characteristics (hardiness and cluster-flowering) and we are now practically back to the point from which we began—hybrid teas.

The major accomplishment, after years of labor, has been only the addition of the orange-scarlet and geranium-red shades to the hybrid tea range of colors. These colors were passed into the bloodstream of the floribundas by the old polyantha varieties 'Gloria Mundi', 'Paul Crampel' and their descendants. They ultimately reached the hybrid teas by repeated crossing of this group with floribundas.

Although there are 333 different and somewhat distinct species recorded in "Modern Roses V" (McFarland), all the major types of garden roses presently popular, have been derived from varieties which have in their lineage two or more of the following eight species; *Rosa chinensis*, *R. damascena*, *R. foetida*, *R. moschata*, *R. multiflora*, *R. odorata*, *R. rugosa* and *R. wichuraiana*. Surely the

potential of the other 325 unused species is great but we can hardly expect the professional hybridist to explore them. He finds it much easier to produce a continual stream of novelties by working with the modern type range of roses.

The problem of discovering the right combination, therefore, appears to rest on the shoulders of the amateur hybridist who is not under pressure to produce, is not bound by tradition, and pursues plant breeding simply for the enjoyment it affords him.

Although modern varieties are approaching the ultimate in blossom form and plant productivity, they are still far from the desired goal of greater hardiness, disease resistance, and an increased range of colors. It seems possible to attain all three of these objectives, and perhaps others, by the use of species roses in which the genes for these characteristics are known to be present.

R. acicularis, for example, offers a good source of extreme hardiness (it thrives above the Arctic Circle) and good foliage, but it does not cross freely with other roses and usually, but not always, produces sterile offspring. 'Pike's Peak', according to the originator's records, is the result of a cross between a hybrid tea and this species. It is a well-known exception to the average result as it is extremely fertile and quite hardy. Unfortunately, it is but a once bloomer and, though attractive, the blooms are only semi-double. Further crosses between it and hybrid teas show a gradual reduction in hardiness and an increase in disease susceptibility. This does not necessarily imply, however, that a happy combination of genes in which the desirable characteristics are retained and others added is impossible. At least it's worth further experimentation.

R. rugosa also has many desirable attributes, such as hardiness, exceptionally attractive foliage, and repeat-blooming. In this instance, however, hardiness and disease resistance are reduced far more rapidly than blossom form is improved. Briefly, when a *R. rugosa* hybrid is produced which has blossoms that approach those of the average hybrid tea in perfection, it has lost most of its hardiness and is extremely susceptible to disease.

In addition to extreme hardiness, *R. suffulta* also possesses the gene for repeat-flowering and several natural forms produce blossoms having more than the normal five petals. Sterility of the progeny of a hybrid tea x *R. suffulta* cross, however, usually serves as a barrier to continuance of this line of breeding. Nature may someday assist in breaking this barrier and the fortunate person who owns the hybrid may be on the threshold of something really worthwhile.

R. nutkana and *R. setigera* are two other native American species with which some work has been done, but neither is extremely hardy and after a generation or two of crossing with hybrid teas they retain but little of it. The lack of inherent hardiness in the case of *R. nutkana* may seem odd to some persons as it is native to Alaska. This is understandable, however, because its area of population is simply along the coast and does not extend into the colder interior. Incidentally, if you should work with *R. setigera,* remember that it is one of the few roses that is functionally dioecious; that is, some plants are male and will not set seed, and 80 per cent of the pollen of the female plants is sterile.

Another American species that has intrigued hybridists since its discovery a few years ago is *R. carolina plena.* This rose apparently possesses every desirable characteristic but one—fertility. However, many roses that have given evidence of complete sterility may occasionally produce a good seed. 'Max Graf' is an example of this phenomenon. *R. carolina plena* is very hardy, has good bush habits and foliage, produces double flowers of an attractive shade of pink and repeats freely. Furthermore, it is a tetraploid and should, therefore, cross freely with the hybrid tea group.

R. chinensis, the original source of the repeat blooming characteristics of our modern roses, cannot be overlooked in any planned line of foundation breeding. It is the most dependably free-flowering

of all species roses and is surprisingly hardy. The one deterrent is that it does not cross readily with other roses and many of the progeny of a successful cross are sterile. Break-throughs, however, are possible and after many years of successes and failures, this species still possesses possibilities for further work. It is a grandparent of the hybrid perpetual class and a great grandparent of the hybrid teas.

R. bracteata, which has become naturalized in many sections of the South, is thought to be entirely resistant to blackspot, and also crosses reasonably successfully with other roses. However, in the fusion of types the desirable features of this Asiatic species are rapidly lost and it is the writer's personal experience that hybrids involving *R. bracteata* are extremely susceptible to blackspot and other foliage diseases.

There is nothing more certain about rose breeding than the uncertainty of the results. Working with *R. spinosissima altaica* is an example of this. Probably no other species rose has been used more by hybridists during recent years. Several of its progeny have been marketed, but only two are dependably recurrent and the best of these proved to be unprofitable commercially because it could not be propagated successfully. I refer to 'Karl Forster', hybrid of 'Frau Karl Druschki', and *R. spinossissima altaica.* Originated by Wilhelm Kordes of Germany, it possesses the desirable characteristics of both parents but is apparently incompatible with the rose understocks now generally used. The other, 'Golden Wings', is my own origination and is presently the highest rated of all yellow hybrid teas. Its parentage is 'Soeur Therese' x (*R. spinosissima altaica* x 'Ormiston Roy'). The last, incidentally, is a *R. spinosissima* x *R. xanthina* hybrid. Although I am naturally proud of the ultimate result, I do not hestitate to say that it was achieved through a lucky combination of genes. You may be equally lucky too, but you will surely not find out if you do not try.

Bosley

'Golden Wings', a single-flowered hybrid tea bred by Roy E. Shepherd, makes an everblooming shrub-type plant

Color objectives in breeding appear to be in the blue, black and brown fields, and they seem to be the most elusive goals to reach. I personally doubt whether a genuinely blue rose ever will be obtained through breeding since delphinidin, the pigment for blue, seems to be entirely lacking in the genus *Rosa.* If, and when, it does appear and a blue rose becomes a reality it will probably result from a mutation of a red rose rather than through the efforts of a hybridist. The nearest approach to blue presently appears to be in the purple-crimsons of the *R. gallica* family and a member of this clan may some day provide a mutation of the hoped-for color. The same group may also prove to be a source of increased "blackness" in the genus.

We may have to reach into the closely related *Hulthemia* genus to obtain a brown-colored rose. *H. persica* has already been crossed successfully with a member of the genus *Rosa* (*R. clinophylla*) and the genuinely brown center of *H. persica* has been passed on to the progeny. This hybrid is so intermediate between the two genera that botanists disagree as to its proper classification and you may find it referred to as either

R. hardi or H. hardi. Unfortunately, it appears to be a rather unhappy hybrid which is quite temperamental, short-lived and reputedly sterile. It does produce an occasional seed but no germination has been reported. However, it may ultimately prove to be an important step in the right direction.

The usual and probably the most practical procedure in working with the species roses is to use a hybrid tea as one parent. Preference and availability should determine which is to be the seed and which the pollen parent. In most instances, the influence appears to be about equal although the species parent (whether male or female) frequently seems to control the time required for seed germination. Only by trial can you determine whether the hybrid tea or the species rose is most receptive to the pollen of the other. As they may differ considerably in this respect, reciprocal crosses are often desirable. Practically all modern hybrid teas are tetraploids and contain 28 chromosomes in each cell. Satisfactory results in seed formation are, therefore, more easily obtained if the species parent is also tetraploid. This information can be obtained by consulting "Modern Roses V" (McFarland).

It is hardly probable that your first cross will produce a seedling of marketable quality, but it may provide a stepping stone to future achievements. The mechanics of plant breeding and seedling care are quite simple and space limitations do not permit their discussion here. This information is readily available from a number of sources, including the Annuals of the American Rose Society.

It is important, however, to mention the matter of pollen retention and preservation because many species bloom far in advance of hybrid teas and it is, therefore, often necessary to keep the pollen in good condition for a month or more. This is done by plucking anthers from an unopened bud of the variety selected as the pollen parent. Place them on a piece of cellophane (about 3" x 4" in size) in a warm room (not in direct sunlight) and permit them to dry for three or four days. Then fold the cellophane (envelope-like), fasten with a paper clip, and place in a jar containing a bit of calcium chloride. This will keep the pollen dry. It should retain its viability for a satisfactory period. I have held it for more than one year.

One final word. Rose seed germination may occur within a month after planting or may require up to seven years. So don't become discouraged!

BREEDING MINIATURE ROSES

Procedures, as well as background information

Ralph S. Moore

THE types of miniature roses that we are hybridizing are comparatively new. The roses are of known parentage and are tested for growing qualities just like their bigger brothers and sisters. In many cases, one of the parents, or grandparents, is a well-known hybrid tea or floribunda! Even so, the bush type miniatures average a foot in height, and miniature climbers rarely exceed 5 feet.

It has been my practice for many years to grow a batch of seedlings (self-set seeds) from the prospective seed parent or parents. This helps to evaluate and to serve as a guide for such traits as viability of seed, per cent of doubles, colors, etc. Usually I make a few hand crosses each year in limited quantity to feel out the value of such crosses. Later the most promising can be repeated to secure larger lots of seed. I feel that I should obtain from 500 to 2,000 or more seeds of a promising cross to really know what it will do.

Most of my best parents are selected

seedlings of my own raising. Miniatures usually set very few or no seeds at all. Some of the more single kinds will set seeds but usually carry only one or two seeds per hip. Thus crossing onto miniatures for seed parents is, in my opinion, not very practical. Instead, I choose a good rose which has as many as possible of the desired characteristics such as color, bud form, freedom of bloom, good foliage, which will easily set seed hips.

While I have used 'Oakington Ruby' directly as a pollen parent, I have hybrids of it which are much better for breeding.

Generally I use hybrid seedlings of bush x climber parentage because they set seed so much easier and in larger quantity. Also, they make possible combinations otherwise unobtainable. Since seedlings from such crosses produce only about 25 per cent bush-type plants I must grow many more seeds but the seeds are so much easier to obtain in quantity. This method has made it possible to produce a number of very good seedlings of *R. wichuraiana* ancestry. Also we have seedlings under test involving other species.

All my crosses are made outdoors during the latter part of April and into May, the flowering season where I live. Flowers are carefully emasculated by opening the petals at the right stage and removing the anthers by grasping them between the thumb and a thin knife blade (such as a budding knife). Pollen is applied soon afterward and the hip covered with a small glassine sugar bag. Instead of marking each hip the cover bag is coded by cutting with the shears in a certain way to indicate the kind of pollen used.

To prepare pollen we gather unopened buds in the evening and first remove petals, then the anthers (same procedure as outlined above in preparing flowers), dropping them into juice or jelly glasses. A small slip of paper with the pollen variety name (or number) is dropped into each glass. These glasses are placed on a shelf or table at room temperature for 24 to 36 hours so the anthers will shed the pollen. I prefer jelly glasses as pollen is easily seen. Pollen is applied with a small brush. I prefer to prepare fresh pollen each night during the pollenizing season so that none is over two to four days old when used.

Seed is left to ripen and here we do not harvest until December. Seeds are cleaned, each cross put into a plastic bag for a day or two or until planted. Usually we try to plant right after Christmas. This is possible because of the mildness of our California climate.

The best method of planting we have found is as follows: Mix by volume one part sterilized soil and one part perlite. Fill seed flats with this mixture, press down and wet thoroughly. Let stand until next day and re-fill wherever needed to bring soil level up to about three-quarters of an inch from top of flat. Moisten again if necessary. Seeds are planted directly on this surface. Cover seed with about one-quarter inch or so of peat moss. On top of this cover with a similar layer of perlite. Water carefully. We use a cool unheated greenhouse for this operation.

When seedlings start to appear a close check is made each day. As they start to flower a small stick marker (made by splitting 4-inch wooden pot labels into three or four parts) is placed beside any interesting seedling. After plants have flowered once we try to pot into $2\frac{1}{4}$-inch pots. Later the best are moved into larger pots from which a few soft cuttings may soon be taken for further tests. This way we do not have to plant out or handle large numbers of worthless seedlings.

The time required to test a seedling varies. If it is a good propagator we can get a good number of plants to test in a short time. The use of a greenhouse hastens the testing. Propagation of soft cuttings under mist also helps. (California climate is also a factor.) If a seedling is difficult to propagate we are not much interested. We find that it takes from four to eight years from the crossing to the introduction of a new variety.

HOW PROFESSIONAL GROWERS HYBRIDIZE ROSES

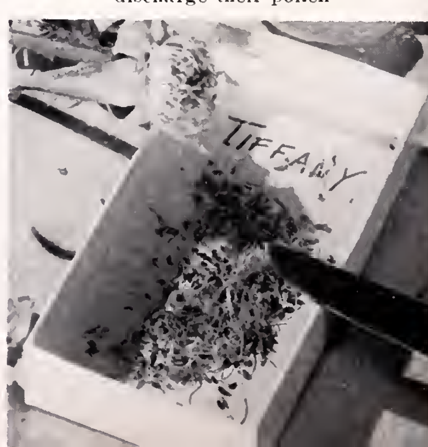
Nurseries which hybridize and introduce their own rose originations are few in number, principally because of the cost involved in producing, growing and marketing a novelty. One of the leading rose firms is the Howard Rose Company in Hemet, Calif. In order to produce one, or at the most a few superior new roses each year, their breeders make an average of 10,000 crosses, plant about 75,000 seeds of which 30,000 may germinate. When the seedlings first bloom, at least 8,000 are eliminated and 22,000 seedlings planted in the fields for further testing, elimination, and final selection. All this breeding is now being done in greenhouses, using from 550 to 600 plants as parents, each one grown in a 5-gallon container. This firm's breeding procedure is illustrated below.

1. Whether a bloom is to be a male or female parent, only unopened flowers, not exposed to foreign pollen, are used

2. First, all petals and sepals are removed with snips or a sharp knife, exposing the stamens clustered around the pistils

3. The female parent has all the stamens removed so as to prevent any possible self-pollination before other pollen is applied

4. Stamens gathered from the male parent are stored in shallow containers to dry and discharge their pollen



5. After the pollen sacs burst, pollen is put in a small jar. To apply pollen to stigmas, whole flower head is thrust into jar

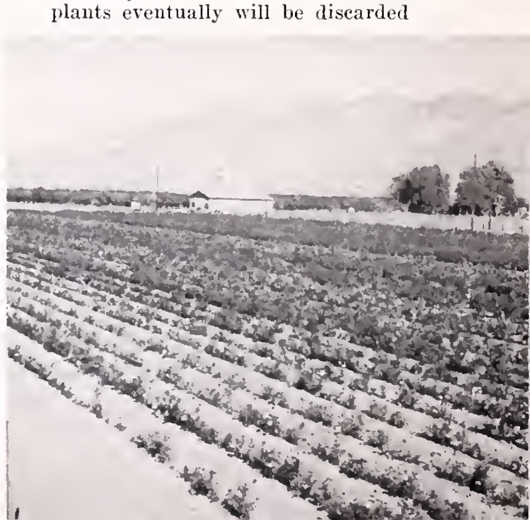
6. A ventilated bag is fastened over flower for protection. Label indicates parentage: female code number above line, male below

7. When the rose fruits (called ''hips'') ripen in fall, they are harvested and sorted according to parentage, before seed removal

8. The hips are cut in half with a knife, and seeds removed. Those that float in water are discarded, the rest are planted

9. After transplanting into pots, seedlings bloom within 6 weeks. Rose breeder Robert V. Lindquist and Botanic Garden Editor Paul Frese inspect initial bloom on hybrids

10. Seedling roses selected for further testing are set out from the greenhouses into trial nursery. All but the best of these plants eventually will be discarded



GLADIOLUS BREEDING

Leo G. Klein

THE mechanics of gladiolus breeding are comparatively simple. Each flower contains three stamens whose anthers bear the pollen or male element of the flower. A single pistil with a three-forked stigma arises from the center of the flower. Each flower which is to be used as the female or seed parent must be emasculated just before or shortly after the flower has opened, otherwise self-pollination might occur. At this time the pistil should be fastened to the uppermost petal with a toothpick to keep it out of the way of visiting insects which may now alight on the lower petal so that they can enter the flower without brushing against the stigma. Another method is the removing of the lower petals of crossed florets, thus eliminating the insect "landing field", used particularly by bees. Gladiolus pollen is heavy and is not moved about by the wind, hence, unlike many other flowers, it is not necessary to bag or cover the emasculated florets.

When the stigma becomes feathery it is receptive and ready to receive pollen from the selected pollen parent. Pollination is usually done by simply brushing the stigma with an anther. For best results, the stamens should be collected at least several hours before needed because pollen from freshly gathered stamens does not brush off easily. Stamens from flowers which have opened outdoors may be contaminated with pollen from other varieties since bees frequently gather pollen and in so doing deposit foreign pollen on the anthers. A good plan to follow is to keep a good supply of blooms indoors which will serve as a source of uncontaminated pollen. These spikes, of course, should be cut and taken indoors before the florets open.

At room temperatures, gladiolus pollen will remain viable for about 6 to 8 days, but may be stored for as long as 15 weeks under conditions of controlled temperature and humidity.

The time of pollination has a marked effect on subsequent seed set. It has been found that pollinations made before 9:00 a.m. and after 7:00 p.m. are more likely to give a good set of seed than pollinations made during the middle of the day. This is particularly true in hot weather.

After a spike has been pollinated tie a label to the stem, giving both parents and the date of pollination. That portion of the spike above the uppermost pollinated floret should be removed to permit maximum seed development.

The seed pods are ready for harvesting about five weeks after pollination. As soon as the pods begin to split they may be taken indoors to dry. The seed will slip out of the pods as soon as they are thoroughly dry and it should be stored in a comparatively cool, dry place until planting time.

The seed may be sown in May in shallow trenches in cold frames or directly outdoors as soon as the soil can be worked. A light mulch of sawdust or fine peat moss will help prevent the soil from drying out. This is one of the real secrets in growing young gladiolus seedlings as they will not tolerate drying, particularly during the early weeks after emergence.

If the seedling bed is given good care, most of the corms will have reached flowering size by fall. They are dug, dried and stored in the same manner as ordinary gladiolus corms. When the seedlings bloom the following year the real fun begins. The ability to "see" a good seedling comes only with experience. However, most of them will be very ordinary and should be pulled up and discarded.

The ones which are selected as being promising are tagged with an identifying

number and the long job of propagation and testing begins. If a seedling receives general acceptance at gladiolus shows as being worthy, it may be named and introduced. It should be kept in mind, however, that a new variety has little chance of success unless it has compiled a good record of show winnings and has received a satisfactory rating from a recognized seedling committee or gladiolus test garden.

Sources of Hereditary Variation

Most gladiolus breeders use only horticultural varieties in their breeding program. These are all tetraploids with 60 chromosomes. Because of their many different colors, types, and complex genetic background, modern varieties provide an excellent source of genetic variation. As for color, all colors in many different combinations are available with the exception of blue. Petal structure varies from plain to extremely heavy ruffling, and floret type from round to triangular, wide-open to "lily" shape. Plants vary from dwarf to tall, and time of blooming varies from very early (60 days or less after planting) to very late (over 100 days).

Floret placement, attachment, the ability to open indoors after cutting, and the ability to hold many blossoms open at one time are all hereditable characters and vary widely among varieties.

Horticultural Varieties as Parents

Most successful breeders keep painstaking records of parental pedigrees and also a list of varieties which they consider to be "good" parental material. Most breeders also have a number of seedlings which they know to have value in breeding. It is probable that the use of such seedlings in breeding is responsible for distinct types of seedlings being associated with certain breeders.

As a variety is introduced, it is listed with its parentage in the annual publication of the North American Gladiolus Council. It is interesting to study these lists and to note that some varieties appear frequently in crosses. It is also noteworthy that many of the very finest varieties seldom appear as parents in these lists. This is further evidence that success in gladiolus breeding, as with other crops, is largely dependent upon a knowledge of varieties and how they will behave as parents.

Some of the varieties which appear frequently in variety pedigrees are 'Picardy' (salmon pink), 'Burma' (rose), 'Florence Nightingale' (white), 'Maid of Orleans' (white), 'Evangeline' (pink), 'Elizabeth the Queen' (lavender), 'Red Charm' (red), 'Harlekin' (red), 'Orange Gold' (yellow), 'King Lear' (purple), 'Ivy Robertson' (pink), 'Golden Goddess' (yellow), 'Greta Garbo' (light pink), 'Rose O'Day' (rose), 'Crinklette' (pink), 'Beauty's Blush' (pink) and 'Rose Charm' (rose).

Of this group, 'Picardy' (E. F. Palmer, 1931) is by far the most important variety. It has produced so many good seedlings that an estimated 75 per cent of all varieties now grown have Picardy somewhere in their ancestry. Picardy's parents were of distinctly different ancestry. 'Emile Aubrun', its maternal parent, was predominantly *gandevensis* type with large florets and the ability to hold many open at a time. Its paternal parent, 'Apricot Glow', was predominantly of *primulinus* type with smaller hooded florets and tall-growing graceful plants. Picardy's diverse genetic background is probably responsible for the many new varieties and types developed from it. Of course, the fact that it has been used in breeding much more than any other variety is probably also partially responsible for its success as a parent.

Some varieties in the foregoing list are of European origin, namely, 'Maid of Orleans', 'Harlekin', and 'Greta Garbo' and since European breeders never publish variety parentages, it is impossible to establish pedigrees when these varieties are used. It is, however, noteworthy that on a percentage basis more European than American varieties are listed as good parents. Crosses between European and American varieties frequently exhibit

Pollination of Gladiolus

Close-up of the gladiolus flower structure, showing three stamens and one pistil with its three-pronged stigma. Black paper is inserted only as a photographic aid

Prior to pollination, the three stamens were snipped off. Here, the stamen of the male parent is being brushed over the stigma. Forceps are used to prevent contamination

more vigor than when American or European varieties are crossed with themselves. It could well be that European breeders have been using varieties which are predominantly of different species ancestry than American varieties. Hence, crosses between European and American varieties would bring together widely divergent types and thus account for the extra vigor. This might also account for the higher per cent of good seedlings coming from such crosses.

Effect of Inbreeding

Being a vegetatively propagated plant, the two main benefits of inbreeding, namely vigor and uniformity in the F_1 generation, do not apply to gladiolus. Further, it has been found extremely difficult to maintain inbred lines beyond the third generation and such lines at this stage are still highly heterozygous for most characters. It would seem that true inbreeding is almost an impossibility with gladiolus, but limited inbreeding involving the crossing of varieties which have several common ancestors has produced progeny with a preponderance of certain characters due to the fact that both parents are contributing factors for the same character.

Mutations

Color mutations in gladiolus are quite common, particularly in some varieties. These color mutations are usually lighter in color than the varieties from which they mutated. 'Picardy', the most widely grown variety in the world, has produced several white mutants, namely 'Leading Lady,' 'Silver Wings', 'Bingo' and 'Wanda', while 'Lady Luck' is a lighter colored pink than 'Picardy.'

'Elizabeth the Queen', a beautiful lavender colored variety, has produced many white and near-white mutations as well as several dull off-white types. The list could go on, but in all cases noted the new color is lighter than the original variety. This would suggest the loss of a color factor rather than an increase in color such as is so common with apples.

After pollination, the stigma is pinned against the uppermost petal with a toothpick, to keep it out of contact with visiting insects, such as bees, and hummingbirds

Paris Trail

When seed pods enlarge, the breeder may assume that the cross has been successful. For crossing, use only the largest flowers toward the base of stalk

There have been no studies to determine the mutation pattern, but in recent studies it was difficult to determine differences in breeding behaviour between several pure white mutants of 'Picardy' (a pink colored variety) and 'Picardy' itself when used in the same crosses. This suggests chimeral type mutations in which the tissue which gives rise to germ cells was not involved in the mutation.

Artificially Induced Mutations

Very little dependable work has been done in this area of study with gladiolus. Where mutations have occurred through the use of X-ray or Gamma radiation, the mutants have been mostly classified as horticultural freaks with little or no value. Similar results have been reported from the use of colchicine.

New Horticultural Types

Many new types have appeared in recent years which may have value in breeding. Some of these are double flowers, spurred or dragon-type florets, and the heavily ruffled, winged "butterfly" types.

Standards, as set up by the North American Gladiolus Council, do not at present recognize these new types and until they are recognized it is not likely that they will become very popular.

The development of fragrance in gladiolus has opened up a whole new field of variation as there are several species with varying amounts and different kinds of fragrance. *G. recurvus* and *G. tristis* both have value in this category.

Breeding Objectives

There has been steady improvement in gladiolus since gladiolus breeding began about 150 years ago. There is even now a very heavy turnover of varieties, with about 100 to 200 new varieties being introduced every year and an equal number dropped to make room for them. The average good introduction has a normal life of about ten years and few persist much longer. Most of the varieties listed

Left. Seedling gladiolus bed. Author sows seed in inch-wide rows and one inch deep, covering the entire bed with an inch of moist peat moss to keep the soil constantly damp and to reduce weed competition

Below. The seedling corms should be dug after the first hard frost. Corms will average one-half inch in diameter, and most of them will bloom the next year

as good parents have survived beyond the usual ten years.

As new and better varieties are introduced, standards or ideals are raised. Thus, new varieties of today probably will not be acceptable by 1969 standards. Styles in flowers also change as evidenced by the tremendous increase in interest in miniature and small types.

Modern gladiolus have a wonderful array of brilliant colors and combinations of colors. However, for some reason there are very few good yellow varieties. Many varieties have good color but make poor growth, have weak stems, too few buds, poor floret attachment, or disease susceptibility. There is no real "blue" color in gladiolus. Although there are several near-blues, here again they are weak and have disease-susceptible plants and corms. Just why there are no really blue gladiolus is not known, but with so many breeders trying for so long to develop a blue variety from the "near blues" it would seem that if the pigment were present and if nothing were preventing its expression, it would have appeared by now.

There is much room for improvement in varieties which will grow under Florida conditions. Test gardens are operating in Florida for the purpose of testing all promising new varieties as they appear. Commercially minded breeders are making crosses with Florida adaptability in mind.

Florida breeders are using as parents varieties which are more resistant to disease, less sensitive to length of daylight, and are vigorous growers. The important parents in the Florida breeding program are, 'Spic and Span,' 'Valeria,' 'Spotlight', 'Bengasi', 'Canopus', 'Carrara'. 'Margaret Fulton' apparently is valuable in breeding for disease resistance, and 'Picardy' apparently can transmit its good characters without transmitting its disease susceptibility factors.

The gladiolus is subject to many diseases, particularly fusarium, sclerotinia, septoria, and botrytis rots as well as such minor diseases as bacterial scab. Virus diseases are becoming increasingly important. Hence, with all these diseases and others which are important in certain districts, it is becoming necessary to make an effort to breed for disease resistance.

Test gardens are operated by the North American Gladiolus Council in many parts of the U. S. and Canada to rate seedlings before introduction. A good test garden rating provides a wonderful boost for a new variety, and most breeders submit promising seedlings for testing before deciding whether or not they are good enough to name and introduce.

The "All-America" Gladiolus Trials were established in 1952. This is an organization of commercial growers who accept seedlings for testing with the object in view of purchasing and jointly introducing any that pass their rigid tests. The first variety to receive an All-America award was the brilliant red 'Royal Stewart', from the 1953 tests, which was introduced in 1956. This development is an added incentive to gladiolus breeders because a winning variety has much greater value commercially simply because of the publicity it receives.

Worthwhile objectives in gladiolus breeding, it would seem, should include improvements in certain color classes, and major emphasis on disease resistance which has been somewhat neglected until recently. It is further hoped that interest in the use of untried species will continue. This is a likely source of germ plasm which might eventually produce the now-lacking blue color in gladiolus and might also provide many genes for disease resistance.

Some good references on gladiolus breeding are herewith listed.

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The author is justifiably proud of his own origination 'Heirloom', with which he is pictured, because it has won top awards at many flower shows

BREEDING CAMELLIAS FOR NORTHERN GARDENS

Francis de Vos

THE southeastern states and the coastal areas of California, Oregon and Washington have been the traditional homes of the camellia in this country for over one hundred years. During the past two decades, intrepid gardeners have gradually introduced camellias with varying results to the more hostile climate of the coastal areas from Norfolk, Virginia, to Long Island, New York.

It was not altogether unexpected when the camellia, aristocrat of southern gardens, did not prove to be altogether hardy further north. Reports of cold damage to foliage and flower buds were numerous and discouraging but always tempered by scattered successes. These successes have been numerous enough as far north as Washington, D. C., and Baltimore, Md., for growers to feel that the help of horticulturists and plant breeders would result in finding and developing camellias better adapted to northern gardens.

General Considerations

The first thing that the potential camellia breeder should do is to acquire a thorough knowledge of the behavior, under varying climatic conditions, of the species and varieties that might be useful in obtaining his objectives. This knowledge, together with an understanding of the principles of plant breeding outlined elsewhere in this publication, forms a basis for his work.

With literally thousands of varieties to choose from, why is it necessary to resort to breeding? Are not the varieties now available satisfactory to meet our needs? There are no simple answers to these questions. Even the most ardent northern camellia enthusiast will admit that many of the varieties that he must choose from are second rate. Also, no individual or institution has tested all existing varieties for hardiness or general landscape usefulness in colder climates. The camellia collection at the U. S. National Arboretum in Washington, D. C. is perhaps the most extensive of the cold-climate collections, but it is composed of only 150 varieties of *Camellia japonica*, 90 varieties of *C. sasanqua* and a few miscellaneous species. Undoubtedly, among the thousands of untested named and unnamed varieties, others besides those now known would be useful in northern gardens. However, we must look to breeding to attain the more spectacular goals.

Breeding Objectives

Although greater cold hardiness is always an underlying objective of most camellia-breeding programs, the primary concern has been improving flower size, color, substance, form and, more recently, fragrance. This approach is understandable when we consider that the plant breeder usually has had in mind the camellia enthusiast who, because he lives in an area where a wealth of varieties can be grown, can afford to be discriminating in his choice.

The person living at the northern fringe of camellia culture cannot or need not be so discriminating. The preoccupation of many camellia gardeners has been with varieties that will win prizes at the annual camellia shows rather than with the overall landscape value of camellias. Varieties unacceptable to more favorably located gardeners may be the best he can hope for. The principal objective of a camellia-breeding program designed to extend the cultural range of camellias northward must first be the cold problem. The approach should be made along the following lines: (1) *increasing flower bud*

hardiness; and (2) *developing forms that will bloom during the relatively frost-free periods of early fall and late spring.*

Increasing Flower-Bud Hardiness

The flower buds of camellias are much less hardy than the rest of the plant. The approximate temperature ranges for bush hardiness and flower-bud hardiness, respectively, of the major camellia species grown out-of-doors in the North are as follows: *C. japonica* −15° to +10° F. and −5° to +15°; *C. sasanqua* 0° to 10° and 15° to 18°; *C. oleifera* −5° to +5° and 15° to 18°.

Cold injury to camellia flower buds may be evident after the first fall freeze during which the temperature drops to 20° or lower, or at any time during the winter. A mild fall, followed by an abrupt freeze, invariably results in extensive bud damage even to varieties that can withstand lower temperatures in midwinter. Observations made by cutting open flower buds after the cold spell on November 24 and 25, 1956, when the temperature dropped to +18°F. indicated that the following varieties of *C. japonica* were able to withstand this freeze without serious injury: 'Adolphe Andusson', 'Are-jishi', 'Gov. Mouton', 'Kumasaka', 'Marjorie Magnificent', 'Jarvis Red', 'Rev. John Drayton' and 'Leucantha'.

The much-heralded Snow Camellia *(C. rusticana)* has not proved to be any more and perhaps is less bush-hardy than most japonicas when not protected by a continuous snow blanket during the winter. Less than one-third of the 200 three-year-old plants of this species survived three winters outdoors in the Washington, D. C. area even though the lowest temperature recorded was only +2° F.

The race of free-flowering camellias developed in England from crosses between *C. saluenensis* and *C. japonica* and known collectively as *C. williamsi* have not yet been tried extensively in northern gardens. Such Williamsi Hybrids as 'J. C. Williams' and 'Donation' have been said to produce satisfactory flowers after exposure to 0° F. Additional crosses should be made between these diploid species by using many of the extremely hardy forms of *C. japonica* now known.

Other interesting crosses that may be worth repeating by using hardier forms are *C. japonica* x *C. reticulata* (a very tender hexaploid species with flowers ranging up to 6 inches in diameter) and *C. saluenensis* x *C. cuspidata* (*C. cuspidata* is a diploid and the hybrid is called 'Cornish Snow').

With the possible exception of the largely untried varieties of *C. williamsi,* the flower-bud hardiness required is confined to the various varieties of *C. japonica.*

Varietal trials at the National Arboretum have uncovered a number of *C. japonica* varieties which produce good-quality flowers after having been exposed to temperatures of 0° to 5° F. They are as follows: 'Adolphe Andusson', 'Are-jishi', 'Berenice Boddy', 'Blood of China', 'Elegans' (Chandler), 'Donckelari', 'Dr. Tinsley', 'Flame', 'Gov. Mouton', 'Herme', 'Jarvis Red', 'Kumasaka', 'Lady Clare',

The ruby-rose colored camellia 'Sparkling Burgundy', which is of the fall-blooming sasanqua type. It survived severe freezes in the winter of 1959 in test gardens in Norfolk, Va., whereas many other sasanqua and japonica varieties perished

Karl H. Riek

'Lady Vansittart', 'Leucantha', 'Magnoliaeflora', 'Marjorie Magnificent', 'Professor Charles Sargent', 'Rev. John Bennet', 'Rev. John Drayton', 'T. K. Variegated', 'Thelma Dale', 'Tri-color' (Siebold) and 'Tri-color' (Siebold) Red.

Unnamed varieties that have shown even greater bud hardiness such as Zimmerman's variety Z (see PLANTS & GARDENS, Vol. 12, No. 3), the Kominato strain from northern Japan and various unnamed varieties that are being uncovered from time to time should also be used.

Whether all the aforementioned varieties would be useful as pollen, seed parents, or both, can only be determined through trials. Varieties with double and peony-type flowers seldom are satisfactory as seed parents, but the same can be said for some of the single and semi-double-flowered forms. The cold-hardy 'Donckelari' and 'Leucantha' as well as the less hardy 'White Hibiscus', 'Dr. W. G. Lee' and 'Mrs. F. L. Gibson', are excellent seed producers.

The excellent performance of the above-mentioned varieties under actual field conditions and the fact that the crosses would be of the intraspecific type and largely between diploid parents* seems to indicate a good chance of developing a race of camellias that would make satisfactory landscape specimens in areas with an average annual minimum temperature of —5° F.

Earlier and Later Blooming Varieties

The development of a race of fall-blooming camellias having the flower quality of *C. japonica* seems to pose a more difficult, but at the same time more intriguing problem. The reason is that 'Are-jishi' is the only variety of *C. japonica* now known which regularly produces some flowers in the relatively frost-free September to mid-November period in what is now the northern fringe of the camellia belt in the East, Washington, D. C. The attainment of this objective will undoubtedly require interspecific crossing of diploid and hexaploid parents.

Fall-blooming camellias are largely confined to the species *C. sasanqua* and *C. oleifera.* These species are about equally cold-hardy, fruit abundantly, and are hexaploids (2n=90). The sasanqua, however, is much more variable in flower form, color, growth-habit and foliage, as evidenced by the more than 100 named varieties. *C. oleifera* is grown as a species and is in little demand because of its poor-quality single white flowers and dull-green foliage. Both species lack the flower quality and general cold hardiness of *C. japonica.* Hybrids having the earliness of *C. sasanqua* or *C. oleifera* and the flower quality of the japonicas would do more for camellia culture in the northern fringe areas than any other single development and eliminate the concern over flower-bud hardiness.

The attainment of early-flowering plus better flower quality and bud hardiness is partially approached in the anomalous and discredited species *C. hiemalis** represented by the varieties 'Shishi-gashira', 'Chiri Tsubaki', 'Meoto-zaki' and 'Sandanka'. Sealy believes that this group of varieties, often called "Winter Sasanquas," actually are sasanquas, but he does not attempt to explain their tetraploid nature. Information as to whether these interesting varieties represent tetraploid forms of *C. japonica* or hybrids from crosses between the hexaploid *C. sasanqua* and the diploid *C. japonica* must await future studies. There are, however, no authenticated records of crosses between *C. japonica* and *C. sasanqua* or *C. oleifera,* but it is encouraging that the tender hexaploid species *C. reticulata* has been successfuly crossed with the diploid species *C. japonica* and *C. saluenensis.* Since *C. reticulata* has the same chromosome count as the sasanquas, every effort should be made to effect crosses between these species.

* There are three known triploid varieties of *C. japonica:* 'Julia Drayton,' 'Nagasaki,' and 'Grandiflora.'

* J. R. Sealy, "A Revision of the Genus Camellia."

The eminent rose breeder Dr. Walter E. Lammerts, who has also done considable camellia breeding, cautions would-be camellia breeders to watch out for apomictic** seedlings when dealing with species at the tetraploid or hexaploid level. He found that, in some crosses involving polyploid species, the seedlings invariably resembled the diploid *C. japonica* female parent in foliage and plant habit. In such cases, the pollen merely stimulated the development of an abnormal diploid egg (a normal egg would be haploid) without actual fertilization.

The difference in flowering time of the fall-blooming camellias and the winter- and spring-flowering *C. japonica* would not seem to offer an insurmountable barrier to crossing. The early-flowering 'Are-jishi' normally flowers along with most sasanquas. Other early-flowering japonicas grown in greenhouses can be made to bloom at the same time as sasanquas growing out-of-doors. Pollen storage offers still another means of crossing species with widely separated flowering periods. It should also be possible to retard the blooming of sasanquas growing under greenhouse conditions by regulating temperature and day length and thereby making them available as seed parents in crosses with winter and spring-blooming species.

Seemingly the possibilities are good for developing varieties that will come into bloom throughout April, when the frequency and severity of frosts are decreasing. Crosses involving the late-blooming Kominato strain with such medium-late bloomers as 'Ville de Nantes', 'Lady Vansittart', 'Rev. John Drayton', 'Kumasaka', 'Leucantha', 'Rev. John Bennett' and 'Blood of China' may well produce late-flowering hardy types for northern gardens.

Camellia-Breeding Techniques

Since camellias bloom when frosts or freezes are likely, the parent plants should be protected. Better results are obtained from crosses made in greenhouses than from those made outdoors. Pollen subjected to temperatures below 60°F. becomes impotent, and new pollinations subjected to temperatures below 25° may be severely damaged.

Emasculating and pollinating camellia flowers is comparatively easy because the parts are large and readily accessible.

Emasculating. Flower buds selected to serve as female parents should be opened and the anthers removed before they split and discharge their pollen. The right stage of development for emasculating may differ with varieties but usually occurs three or four days before the petals unfold. The petals are often removed at the time of emasculation. After emasculation, the flower should be covered to prevent chance pollination. Kraft paper bags secured to the stem below the flower with a Twist-Em tie, staples, or paper clips are satisfactory.

Collecting and Storing Pollen. Pollen from selected male parents may be collected in a number of ways. The pollen may be shaken from the anthers into a small envelope or the anthers may be removed and placed in small gelatin capsules just before they open; or at the time of pollination the ripened anthers can be removed with tweezers and applied directly to the stigma of the female parent. In all cases it would be well to cover the flowers before the anthers are ripe, to avoid contamination.

Limited tests have shown that pollen from early-flowering varieties may be stored successfully as long as two and one half months at room temperatures by placing No. 1 gelatin capsules, half-filled with pure pollen, in a large test tube containing anhydrous calcium chloride.

Pollination. Usually within three days after emasculation the stigma becomes swollen and sticky and is said to be receptive. The pollen, whether recently collected or stored, is applied in copious quantities to the stigma with a camel's-

** Apomixis is the ability of a plant to form seeds without the process of fertilization.

hair brush, or, the stamens from the male parent including the ripe anthers may be picked off by hand and the pollen applied directly to the stigma. After pollination, the flower should be covered again and the branch bearing the potential seed capsule labeled with the name of the female and male parents and the date of pollination.

Once the style of the pollinated flower begins to wither, it is safe to remove the bag. Whether an initial "take" has been effected and fertilization has taken place can be determined by the condition of the ovary, which begins to swell within three weeks after pollination and provides a contrast to the shriveled ovary of unfertilized flowers.

Collecting and Germinating the Seed. The seed is ready for harvesting at the time the fruiting capsule begins to dry and crack open. Under outdoor conditions, the seeds are usually gathered in early fall. To prevent the loss of seeds from capsules that may open before collections are made, the fruit may be enclosed in a cheesecloth bag in late summer.

Camellia seeds should be sown immediately after they are harvested. Seeds placed in a container of damp peat from which no water can be squeezed, placed in the shade or moderate light and kept at a temperature of 65° to 75°F. will germinate within 10 to 30 days. When the young root is about 1 inch long the germinating seeds may be transferred to a flat containing a 50-50 mixture by volume of sand and peat and placed under light shade. When the stems have elongated to 3 to 6 inches they can be potted in a composted soil of pH 5.5 to 6.5.

The embryo-culture method for germinating hybrid seed is of special interest to hybridizers since the seeds resulting from interspecific crosses often contain defective embryos and can be germinated only by this method. For information on this technique the reader is referred to the article on embryo culture in the suggested reading listed at the end of this article.

Concluding Remarks

Despite the alluring goals that have awaited would-be camellia breeders there has been relatively little planned breeding with these outstanding plants. Among the possible reasons are the high mutation rate which has provided a constant supply of variation and the difficulty of at-

When this camellia fruit starts to crack open, it should be enclosed in a cheese-cloth bag so the seed will not be lost

Author photo

Camellia seedlings can be grown in cans the first year or two prior to being planted out in nursery rows for flowering

Frese

Part of the labelled collection of *Camellia japonica* varieties at the National Arboretum in Washington, D. C., where amateurs may see many of the best kinds in cultivation

taining large hybrid seedling populations that would enable the breeder to uncover superior types. The azalea breeder may expect 200 to 500 seeds per capsule, whereas the camellia breeder is fortunate if he averages two.

Although the frequency of mutations can probably be increased by radiation techniques, the plant breeder cannot look to this method for fulfilling specific objectives. There is no controlling the type of mutation that appears. Controlled intra- and interspecific hybridization should, in the long run, provide superior camellias not only for northern gardens but for wherever they can be grown.

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A young grafted camellia plant. Seedling camellias which prove to be worthless still may make excellent understock on which to graft other varieties or selected seedlings
Frese

HOLLY BREEDING

William F. Kosar

USE of holly in the landscape and during festivities dates back several centuries. For generations the Chinese have cultivated one of their native hollies, *Ilex chinensis,* and used berried cuttings during their New Year festivals in February. The Japanese holly (*I. crenata*) has long been used in landscapes and also as dwarfed potted specimens called "bonsai." English holly (*I. aquifolium*) has been widely used for hedges and for its berried sprays during the Christmas season. Use of sprays of American holly (*I. opaca*) at Christmas time developed when the colonists substituted it for English holly. The trend today is toward greater use of the evergreen holly species in landscape design.

Author photo

This plant of 'Dwarf Burford' holly (*Ilex cornuta*), thirteen years old from a cutting, is a mutation which is both low and slow growing. It is better for many uses than its tall parent. Amateurs may occasionally detect mutations such as this among their own plants

Distribution of Genus Ilex

Dr. Shiu-ying Hu, outstanding holly scholar working at the Arnold Arboretum, states that over 400 distinct kinds of holly (species) are distributed in the tropic, subtropic, and warm temperate zones of the eastern and western hemispheres. Dr. Hu describes 120 species from China and Japan. Three species occur in Europe, while approximately 20 species are native to eastern and southern United States. A majority of the remainder occur in Central and South America. Australia is the only continent without native hollies.

Principal Evergreen Holly Species

Except for the black-fruited Japanese holly, varietal selection within the genus *Ilex* has mainly centered about red-fruited evergreen sorts. Of the cultivated Oriental hollies, the two most popular species are the Chinese holly (*I. cornuta*) introduced in 1846 and the Japanese holly (*I. crenata*) introduced in 1864.

Until recently not much selection was done within the Chinese holly. The species is noted for its viciously spiny, glossy, dark-green leaves and bright-red clustered fruits, which are often produced parthenocarpically when a suitable pollinator is absent. The best-known horticultural variety is 'Burford', a heavy-fruiting clone whose dark-green convex leaves are usually entire, with a single spine at the apex. The recently introduced 'Dwarf Burford', a miniature mutation of 'Burford', is destined to fulfill the need for a red-berried dwarf in many gardens.

'Shangri-La', a patented orchard-type holly for the southern states, is the result of controlled hybridization of two superior parents and the selection of an offspring for a specific purpose, the production of berried sprays. Variation in berry color is evidenced by two cultivars, 'Avery Island' and 'D'Or', both yellow-fruited.

Dr. James A. Foret, of Southwestern Louisiana Institute, recently described nine Chinese holly cultivars selected from approximately 300 seedlings. They originated from seeds introduced by the United States Department of Agriculture during the late 20's and were planted as a hedge along a pathway of Avery Island, Louisiana. Thirty years of observation and comparison finally resulted in several named selections from this highly variable population.

Japanese holly (*Ilex crenata*) is a compact, fine-textured, black-berried, spineless, evergreen species widely used for general landscaping. Many of our Japanese holly cultivars are merely introduced botanical forms which are vegetatively propagated. These include *Ilex crenata convexa, I. c. latifolia, I. c. longifolia, I. c. mariesi* and *I. c. microphylla*. Plantsmen often grow seedlings from the female forms, such as *I. c. convexa,* and select types of a desired habit that perform well under their environment. As a result, many new selections are offered by nurserymen and many more are still under test. In keeping with the contemporary interest in desirable fine-textured, low-growing ornamentals, the trend is toward small-leaved dwarf selections. Because of the inconspicuous black fruit of *Ilex crenata,* sex is not a critical selection character. Emphasis on ultimate size, habit, texture and hardiness is more important.

English holly (*Ilex aquifolium*) is the most variable and most useful of the cultivated species. Some of its cultivars have been under cultivation in Europe for over 200 years. Mutations and seedling selections during this long period have added considerably to the number of available variations. The concurrent development of holly culture in the Pacific Northwest since 1850 has increased the commercial usefulness of this species. The first plantings in the United States were developed from seeds or plants originating in England. During the 1900's English holly seedling orchards for Christmas spray production were established near Portland, Oregon. These orchards were usually planted with seedling strains developed by the individual grower. At first a pigmented strain called the "French-English" or "Bluestem" was in demand. During the last 30 years the trend has been towards the "Dutch-English" or "Greenstem" strains.

The Eastern U.S.A. has experienced only mediocre success with English holly because of dependence on the European cultivars not particularly well suited to the region. Some growers are importing Northwest cultivars in the hope of obtaining selections that may be cold-hardy or heat-tolerant. The final solution is to produce seedling populations from superior parents doing well in the East, and from them develop selections for various sections of the eastern United States.

American holly (*Ilex opaca*) is the largest of the red-fruited evergreen species to receive horticultural attention. More than 300 named cultivars have been introduced from the wild during the past 30 years. Because of the extensive native range of *I. opaca,* Massachusetts to Florida and west to Texas and Missouri, cultivars differ as to their performance in a particular hardiness zone. In American holly orcharding, profitable production largely depends upon a proper choice of cultivars suited for a particular geographic area. The improvement of American holly for landscape use or orchard production is still in the initial stages of testing named introductions under varying eastern environments.

Improvement Within a Species

Most holly cultivars have originated through simply selecting from the woods (or from seedlings grown from collected seeds) an individual that has a combina-

tion of traits which appear superior to or different from those in the surrounding population. The selection is propagated by cuttings and introduced as a named cultivar. Its value is determined only after it has been thoroughly tested in comparison with other cultivars of the same species.

Controlled hybridization within a species entails the use of known parents, each contributing certain superior genes that we hope will combine to produce progeny better than either parent. This type of systematic improvement has been partially followed in the Northwest. The majority of recent English holly cultivars are descended from superior female selections, however, since the paternal parent is unknown in most cases. Even though the primary objective is to select outstanding females, any male "sibs" of good character should be preserved for use in future breeding.

Holly trees are of separate sexes. That is, some have only pollen-bearing flowers —and are commonly referred to as "male" trees. It is the "female" (or pistillate) trees that bear the holly berries. The fact that the flowers are of different sexes and are borne on different trees, often necessitates a slight modification of conventional breeding procedure. Usually it is simple to combine in an individual selection desirable traits displayed by species with hermaphroditic (both sexes together) flowers. Likewise, it is simple to effect the combination in holly if the selections carrying the desirable traits are of opposite sex. How can the combination be effected if both selections are fruiting females? A possible approach is to produce an F_1 population from a female with desirable traits other than fruiting. Any male of good character can serve as pollinator. An F_1 male similar in appearance to its maternal parent is selected for hybridization with the second desirable female. If because of recessive genes the desired combination is not found in this second population, a third population produced by sib-mating selections from the second population may be necessary.

It would indeed be an asset to holly culture, both from a breeding and a landscape standpoint, if male counterparts of the better female cultivars were available within the red-fruited evergreen species. The majority of the female cultivars set fruit only when a pollinator of the same species, flowering at the same time, is located nearby. A male cultivar used as a pollinator could also fit into a landscape design. For instance, a dwarf entire-leaved male Chinese holly would be of value as a pollinator and still not be an objectionable landscape subject. Male cultivars similar in character and origin to some of the recently introduced females, should be preserved in the "gene bank" of all who are interested in breeding holly.

Improvement by Crossing Different Species

It is possible to produce hollies that are hybrids between different species. However, some combinations of such different parents are diffcult to make because of different times of flowering or genetic incompatibility such as different chromosome numbers. The first difficulty is overcome by storing pollen or manipulating the environment to obtain simultaneous flowering. Flowering sequence of various holly species at the U. S. National Arboretum in 1959 is presented on page 78. If a great many cross-pollinations are made it will increase the chances of success.

Interspecific hybridization in cultivated hollies may have had its beginning in the accidental crossing of English holly with *I. perado* or *I. platyphylla* of the Canary Islands during the latter part of the 18th century. The effects of this crossing are still noticeable in some of the English holly cultivars grown today.

Several putative interspecific hybrids have been introduced as cultivars. They demonstrate the interesting variations that may be expected from a combination of species. Among the more popular are *I.* x 'Brilliant' (*I. aquifolium* x *pernyi*); *I.* x 'Nellie R. Stevens' and *I.* x 'Dr. Kassob' (*I. aquifolium* x *cornuta?*); and *I.* x 'Foster' (*I. cassine* x *opaca?*).

Crossing *Ilex cornuta* 'Burford' (left) with *I. pernyi* (right) resulted in the interspecific hybrid in the center (*I. cornuta* 'Burford' x *I. pernyi*) which has the large foliage of one parent and the leaf form of the other

The first concerted efforts to produce interspecific hybrids through controlled pollination were started in the early 1950's. Many of these hybrids have no practical value except to further our knowledge of the relationship of species. Some may prove to be of immediate ornamental value because they combine desirable characters. Still others may serve as a "bridge" for difficult interspecific combinations. One example is *I.* x 'Foster', which may be backcrossed easily with *I. cassine* or *I. opaca.* In addition it will cross readily with two other species, *I. aquifolium* and *I. cornuta.* This affords a breeding method whereby different combinations of the better cultivars of *I. aquifolium*, *I. cornuta*, and *I. opaca* may produce entirely new variations suitable for a specific environment. The holly breeder has a vision of creating hollies different from any now in existence and perhaps some with remarkably valuable characters, notwithstanding the difficulty in making crosses between different species.

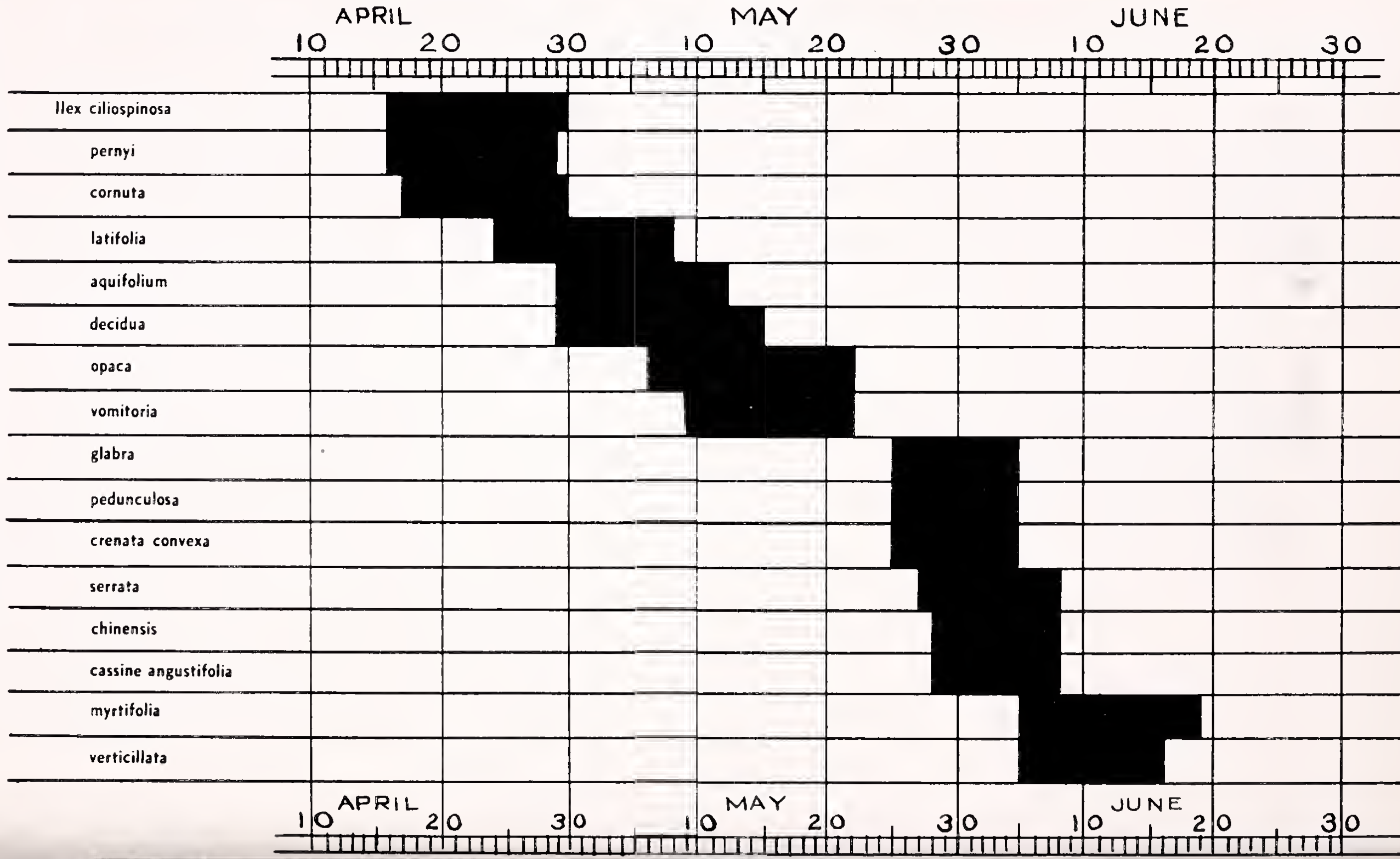
Crossing Techniques

Holly species produce flowers either on the basal part of new growth (American and Japanese hollies) or on growth of the previous season (Chinese and English hollies). As pointed out above, holly produces male and female flowers borne on different plants. The male is recognized by the abundance of flowers produced, the plump yellow anthers and the aborted pistil. The female has fewer flowers, withered whitish anthers and a plump pistil which has a viscid stigmatic surface when it is receptive.

Since the sexes are separate in holly, there is no need for emasculation. However, flowers of both parents must be protected against possible insect contamination by muslin bagging or by working with specimens in a screened greenhouse. Since holly flowers on a single plant do not open simultaneously the interval between the first and the last flowers to open may be as long as two weeks in some species. In preparation for cross-pollination a female branch is cleared of old flowers and any unopened flower buds not used in the cross. As soon as the female flower is fully open, it is in the receptive stage. The pollen from the male parent is applied to the viscid stigmatic surface of the female flower. The simplest procedure is to hold a male flower with forceps and brush the anthers against the stigmatic surface.

If the parents flower at a different time, stored pollen is used. The pollen

1959 Flowering Sequence of Holly Species at the National Arboretum



is collected on wax paper, placed in a labelled vial, and stored with a desiccant (silica gel or anhydrous calcium chloride) in a refrigerator at about 40°F. A camel's hair brush is used to apply the pollen. The use of stored pollen may be necessary with an interspecific cross.

All crosses are labelled and immediately protected against unwanted pollen, by bagging. Approximately four to six months elapse between pollination and harvest. The label accompanies the ripe fruit when it is harvested. Freshly harvested fruit is crushed and washed free of its pulp. At this time empty seeds may be floated off. The viable hybrid seeds will sink to the bottom of the container.

The hybrid seeds are sown immediately in shredded sphagnum and placed in a cool greenhouse. Seeds of *I. crenata* will usually germinate within 90 days, but seeds of *I. aquifolium, I. cornuta* or *I. opaca* may require from one to several years to germinate. While the seedlings are still in the two-leaf stage they are transplanted from the seed flats. It is wise not to discard the seed flat for a year or two in case it contains any tardy germinators.

Hybrid holly seedlings are best handled in shaded frames or lathhouses during the first two years, and then lined out in wider-spaced nursery rows. Each shift to a wider spacing should be accompanied by critical selection. A few characters such as hardiness, rate of growth or leaf quality may be observed at an early age. Others, such as sex or fruiting habits, may be delayed four to ten years. It is wise to initiate the selection phase early so that the final comparison is reserved for superior progeny.

The rate of progress in holly breeding depends on several factors. New hybrids are created through the imagination and experience of the breeder. He must be observant throughout the program, be able to spot the superior individuals, and be strong-willed in discarding the inferior ones as soon as possible. It is a mistake to name and introduce countless selections that have only slight variation and are no better than established cultivars.

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The male flower of English holly (left) has four pollen-laden stamens and a non-functioning pistil in the center, whereas the female flower (right) has abortive stamens and a large pistil in the center. It is the ovary (at the base of the pistil) which develops into a holly berry

National Arboretum photo

AZALEA BREEDING

With special attention to parent stocks and longer term objectives

Frederic P. Lee and Henry T. Skinner

About 4,800 azaleas have been named by hybridizers over the past century and a quarter. About 3,000 of these are still available here or abroad. Thus, there is no need for "just another azalea"! A glance at "The Azalea Book," published a year ago, will demonstrate this. It lists around 60-odd hybrid groups, the work of breeders, past and present. Parentage of named varieties within each group is given in many instances.

When amateurs go in for hybridizing, selecting, and naming new plants, it is important that they be familiar with the many species, varieties, forms of species and clones now in cultivation. Too often amateurs have merely retraced the route of older breeders. Too often a certain simple wonder beclouds their judgment in the face of new seedlings. As a result, azaleas are introduced that are inferior or only slightly superior to even the few named varieties regularly used *ad nauseam* and *ad infinitum* by the run-of-the-mill nurseryman and gardener.

Breeding aims and ideals

Azaleas are one of the 43 series of plants placed botanically within the genus *Rhododendron*. The wild species of azaleas are natives of a small portion of the world—Eastern North America (the United States and Canada), and Eastern Asia (Korea, Japan, China, Formosa, Philippines, and central Vietnam). Two other species are found, one in the Caucasus-Black Sea region, *flavum;* and one in the Pacific states of Oregon and California, *occidentale*.

* The authors have used freely the hybridizing materials in "The Azalea Book" by Frederic P. Lee, D. Van Nostrand Co., Inc., 1958, to which extensive contributions were made by B. Y. Morrison, Henry T. Skinner, and John L. Creech.

The Series Azalea is subdivided into six subseries. The important introduced species of these subseries and their hybrids constitute the basic materials available to the azalea breeder. They are:

SUBSERIES LUTEUM which includes all but two of the deciduous species of the United States, as *alabamense, arborescens, atlanticum, austrinum, bakeri, calendulaceum, canescens, nudiflorum, oblongifolium, occidentale, prunifolium, roseum, serrulatum, speciosum,* and *viscosum,* and three azaleas, *japonicum, molle,* and *flavum,* from foreign areas.

SUBSERIES OBTUSUM which includes the evergreen or persistent-leaved species of China, Japan, Korea, and Formosa, as *indicum, kaempferi, kiusianum, macrosepalum, microphytum, mucronatum, obtusum, oldhami, phoeniceum, poukhanense, rubropilosum, scabrum, serpyllifolium, simsi, tosaense,* and *tschonoski.*

SUBSERIES SCHLIPPENBACHI which includes the fine deciduous species from Korea, China, and Japan, as *amagianum, mariesi, quinquefolium, reticulatum, schlippenbachi,* and *weyrichi.*

SUBSERIES CANADENSE which includes the deciduous species *canadense* and *vaseyi* from the United States and *pentaphyllum* and *albrechti* from Japan.

SUBSERIES NIPPONICUM which includes only the deciduous species, *nipponicum,* from Japan.

SUBSERIES TASHIROI which includes only the evergreen species, *tashiroi,* from the Ryukyu Islands near southern Japan, and probably this species actually belongs in subseries OBTUSUM.

Each subseries (other than the monotypic NIPPONICUM and TASHIROI) represents within itself azalea species that appear to be closely allied in the processes of evolution. Consequently, matters of

hybridization and propagation, as well as of cultivation, flower-color range, and flower form, which differ between species in different subseries, generally are more similar for species within the same subseries.

In addition to the more familiar azalea species, listed above, there are over twenty-five foreign species in the wild not yet introduced to cultivation but of possible help to future breeders.

Races of Azaleas Needed

The hybridizer should have a clear concept, practically a visual image, of what he wants to attain by each cross. In forming that image an extensive knowledge of the existing hybrids and species is necessary. The hybridizer should not engage in promiscuous pollen daubing and indiscriminate selection of seedlings. Too many nurserymen are selling new names, frequently enticing names, although the new plant, while good, is no better than a dozen others already on the market. This is particularly true today in the selection of new evergreen Kurume and Kaempferi Hybrids and deciduous Knap Hill Hybrids. It has long been true of the Belgian Indian Hybrids. As examples of breeding for specific regions and climatic zones, one might point out the following and say that among the new azaleas needed for the future are—1. A race of deciduous azaleas for the southern United States, particularly the Lower South, that will withstand heat and drought and not dwindle away. The materials for such a program and its objectives are discussed by Skinner in the National Horticultural Magazine for January 1958. Warm climate Coastal Plain and Piedmont species with a great range of color, fragrance, and blooming period are at hand from which one might hybridize to achieve such goals. Potential parent stocks are: yellow *austrinum;* pink, *canescens;* red, *speciosum, bakeri*, and *prunifolium;* white, *atlanticum, alabamense, viscosum, arborescens* and *serrulatum*.

2. A race of more readily propagated deciduous azaleas. Few deciduous azaleas can be increased readily from cuttings except with mist equipment, and propagation by layering is slow. *Atlanticum*, however, is stoloniferous. *Alabamense* tends to be stoloniferous, and occasional individual plants of other species show this tendency. They form the basis for a race that could be propagated by division. Cuttings of *atlanticum, viscosum, canescens, austrinum* and *arborescens*, root far far more readily than do those of *japonicum* and *molle* which have been involved in so many of the older garden hybrids.

3. A race of hardier evergreen azaleas for the northern areas of the United States. From the Far East come numerous promising parental stocks (see subseries OBTUSUM). For example, *poukhanense* and *kaempferi* have been used as parents but little has been done with some of the hardier small-leaf azaleas such as *tschonoski* and *serpyllifolium* or clones of *kiusianum* from mountain tops or of

Azalea 'Albicans', an old *A. molle* x *A. occidentale* hybrid, creamy white with yellow blotch. It is believed that much of the *occidentale* influence found in the Knap Hill and Exbury azaleas came from such a hybrid as this

National Arboretum photo

kaempferi from the northern extremity of its range in Japan.

4. A race of yellow to orange flowered evergreen azaleas. Yellow pigment is present but obscured in some of the evergreen azaleas.

5. A race of azaleas equal in beauty to the finest of the Belgian Indian Hybrids (which are a greenhouse group for most of the U.S.A.), but hardier. This is a project on which B. Y. Morrison, originator of the Glenn Dale Hybrids, is at work now at Pass Christian, Mississippi, his home since he retired from his career with the U.S. Department of Agriculture.

6. A race of fragrant evergreen azaleas. *Macrosepalum* and *mucronatum* are species with a faint fragrance. Delightful fragrance is found among many deciduous species.

7. A race of late summer and fall-blooming deciduous azaleas for north temperate climates. Here *prunifolium* and *serrulatum* would suggest themselves as parental stocks.

8. A vigorous race of dwarf early-blooming azaleas. The Yerkes-Pryor Hybrids, not yet generally available, are selected dwarf Kurumes but frequently lack vigor. There are many late blooming dwarfs among the Satsuki and Glenn Dale Hybrids.

9. A race of dwarf deciduous azaleas. *Bakeri* has dwarf forms and *atlanticum, alabamense* and forms of *viscosum* are frequently low growing.

10. No one knows what would result from large scale breeding within the Canadense and Schlippenbachi Subseries.

Theoretically all species within each subseries of the Azalea Series will interbreed. This is generally borne out in practice, although there are exceptions. There is evidence that crosses can be accomplished between plants of different azalea subseries, but the records are few.

Cross-Fertilization

In general, azaleas are comparatively self-sterile, but readily cross-fertile. If a choice exists, it is not advisable to fertilize with pollen from the same flower, or from another flower on the same individual plant, or from another plant of the *same* clone, even though "selfing" or self-crosses have sometimes been successful. For maximum "take" and for maximum vigor of the offspring, the stigma of a flower should be fertilized by pollen from *other* clones of the same species or same hybrid group, or by pollen from another species or hybrid group within the same subseries.

Apomixis

The difficulty in ascertaining whether a cross has actually occurred lies in the possibility of apomixis (reproduction without fertilization but apparently viable seeds formed). Particularly in wide crosses, unless the characteristics of both parents are clearly apparent in the offspring, there is this likelihood. In apomixis, seeds are produced from accessory cells within the embryo sac and not from union of the egg and pollen cells as in normal fertilization. Therefore, these apomictic seeds (except in the case of haploid apomixis) give rise to plants, called *apomicts,* which are identical with the mother plant. Apomixis is, in substance, another form of vegetative reproduction and there is evidence that it may be expected, on occasion, in azaleas.

Apomixis, however, is not to be confused with maternal dominance in which the first generation of a cross may resemble the female (or male) parent in all conspicuous characters. First generation hybrids of *poukhanense* will often look almost exactly like *poukhanense* in flower color, foliage and habit, although a second generation from sib-matings will show, in their variability, that a perfectly good cross has actually been made.

Polyploidy

Among azaleas, polyploidy (the presence of more chromosomes than 26), may hinder hybridization. The basic chromosome number for rhododendrons, including azaleas, is 13. Species usually have 26 chromosomes, this being the diploid number. Only a few azalea species are polyploids. According to present infor-

mation these are *calendulaceum*, or at least the best-known, earlier-flowering phase of the species, and *canadense*, both of which have 52 chromosomes, thus being tetraploids. Most natural hybrids with *calendulaceum* are, like it, tetraploids, but a few are triploids. A triploid has been noted in the otherwise diploid *atlanticum*. Among certain of the new Japanese Satsuki azaleas, both triploid and tetraploid varieties have been reported.

No polyploids artificially created by the use of chemicals or radiation are known among azaleas. In first breeding attempts, it would be well to avoid basing too heavy reliance on combinations with either *calendulaceum* or *canadense*. If seed is set, it will be only a small quantity, some not viable, with some of the seedlings unable to survive.

Assuming reasonable closeness of relationship, one can say that diploids should combine fairly easily, that combinations with a triploid may be very difficult, that diploids and tetraploids will combine on occasion, and that tetraploids with tetraploids may be easy or difficult according to the genetic make-up of the strains involved. While *calendulaceum* x *calendulaceum*, for instance, may produce abundant fertile seed, *calendulaceum* x a suspected tetraploid Exbury hybrid (from the Exbury Gardens in England) may be successful or entirely disappointing.

Inheritance

The few reciprocal hybrids between species observed so far offer no evidence of any advantage in reciprocal crosses. To date, backcrosses (child-parent crosses) have generally not been worth the labor involved, except in those special cases where particular characters in the parent are deemed essential. While sibcrosses (sister-brother crosses) are worthwhile to necessary following up of the species cross, they may contribute little if the parental lines are already mixed.

Seedlings raised between parents with flowers of markedly different size usually give flowers of intermediate size in the first generation. Seedlings from parents blooming at widely different times gives an intermediate time of bloom in the first generation, but a spread approaching that of the parents in the second. No suggestions can be offered as to color inheritance, except that white is usually recessive and that pattern in the form of stripes inherits as a recessive to solid color. In species combinations white crossed with orange-red (as in *arborescens* x *bakeri*) will yield a nicely graded selection of pinks, while pink times orange-red (as in *nudiflorum* or *roseum* x *bakeri*) will provide a selection of the buff and salmon tones of current popularity. A second generation from the cross involving *nudiflorum* will result, strangely, in a number of clear or tinted whites of larger size, usually, than either parent.

Especially to be emphasized is the need for an always discriminating selection of the *best* individuals for crossing —those selections of a species which have the best color or the largest flowers or most desirable habit, as well as those individuals of the first generation hybrids, which most effectively exhibit the characters desired. Real improvement in a breeding program can result only from working with the best possible starting materials, and time spent on the search for such will never be time wasted. Indeed, an extended search for superior parent stock is the first *great* step in any breeding program.

Perhaps few breeding objectives have been more persistently pursued than the attempt to introduce yellow into the evergreen or semi-evergreen hybrids by the crossing of deciduous and evergreen types. While such attempts have never been successful, the progress has sometimes been sufficient to suggest that the objective may eventually be attained. Viable seeds from such crosses are often set but the resultant seedlings are usually chlorotic and soon die. In recent years, however, a few unmistakably hybrid plants have been raised and flowered, but progress has stopped there because such plants have all been "mules" incapable of further reproduction. But the fact that hybrids can be produced is at least encouraging.

THE STORY OF THE BLUEBERRY

A romantic account, with lessons for the future

George M. Darrow

THE blueberry is one of our leading small fruits, primarily because of the vision and hard work of one man—the late F. V. Coville, of the U. S. Department of Agriculture. He had a natural interest in this fruit. He had picked the wild blueberry in New Hampshire and, as head botanist of the United States, was familiar with several of the different species.

He began his serious blueberry work in 1906, when about 40 years of age, and continued until his retirement at 70. He first selected superior-fruited, native, lowbush (the Russell) and highbush (the Brooks) blueberries in southern New Hampshire for crossing but continued his search for superior wild bushes for breeding during the entire 30 years of his work, first in eastern United States, then the whole United States, and later even testing species from other countries.

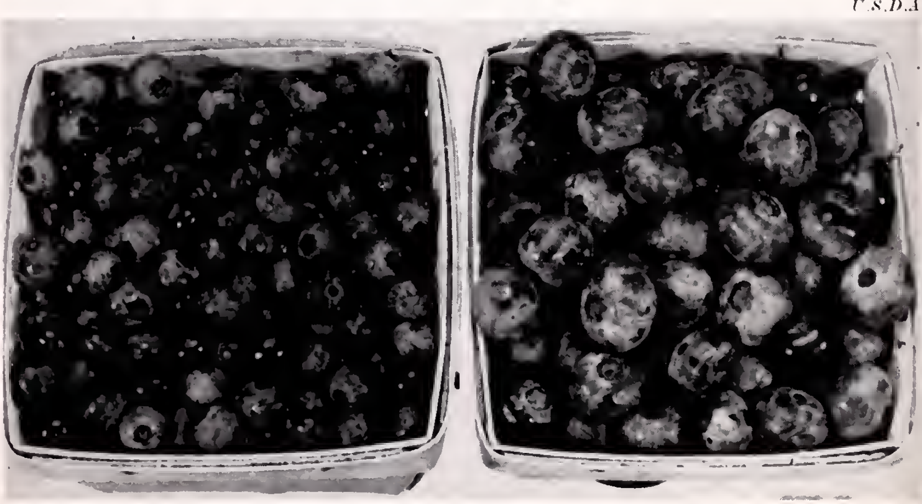
Many of the fine qualities of present blueberry varieties (high flavor, light blue color, large size, vigor of bush) are due to his vision of what was needed for a commercial industry and of his selection of wild parents with those qualities. Some of the first blueberries introduced were not without limitations (such as poor scars left on the fruit in harvesting) because he did not at first appreciate the full importance of such characteristics.

During the early years, he used a greenhouse for crossing and raising seedlings, later supplementing the greenhouse with field crossing. After 1910, the seedlings were fruited in New Jersey, later still in North Carolina and other states.

The first shipments of fruits from cultivated planting were in 1916, but the first cross-bred varieties—'Cabot', 'Pioneer', and 'Katharine'—were introduced in 1920. Altogether, 29 varieties resulting from his work have been named and introduced and the entire cultivated industry consists of these varieties and

'Rubel' (left) is the best blueberry ever selected and developed from wild plants. 'Berkeley' (right) a light blue variety, demonstrates how size of fruit has been increased through breeding. It is sometimes debatable in a case like this whether such qualities as taste and texture improve with size

U.S.D.A.



of the 'Rubel', a selection from the wild.

Dr. Coville, first by himself and later with the assistance of associates and cooperators, examined wild bushes in areas where the blueberry was a dominant plant over thousands of acres of swamp land—in New England, New Jersey, and North Carolina. Rewards were offered for information on bushes with large berries (half-inch or over), and many posters placed in areas where commercial picking from wild bushes was practiced. Many superior bushes were located, propagated, and used as parents in breeding. The 'Brooks' highbush and 'Russell' lowbush of New Hampshire, the 'Rubel', 'Sooy', 'Grover', 'Harding', and 'Chatsworth' from New Jersey, and the 'Crabbe 4' and 'Crabbe 6' from North Carolina were some of the more notable of these selected wild bushes.

During Dr. Coville's lifetime, about 70,000 seedlings were fruited. Since his retirement, about 30,000 more seedlings of his breeding were fruited and the best selected for naming. Dr. Coville and associates would walk the rows of seedlings weekly during the harvest season, tagging and making notes on the best. These were then propagated and those proving superior named. In his later crosses he used the best of his own breeding as parents, thus having much finer parents than in his earlier work. The most recent introductions from those finer parents have proved much superior to the earlier varieties and are termed "The Big Six"—'Earliblue', 'Blueray', 'Bluecrop', 'Berkeley', 'Herbert', and 'Coville'.

The most recent variety to be named, 'Blueray', is very large, about the size of 'Berkeley', 'Coville', and 'Herbert', ranks with the best in flavor, is firm, and has good color. It descended from five of Dr. Coville's earlier varieties—'Katharine', 'Pioneer', 'Stanley', Jersey', and 'June'—and they in turn from five different wild plants. The cross was made in 1934 and the seedlings raised in 1935. After 20 years, it had fruited, been selected, propagated, found superior to any of its season, and hence named.

In preparation for pollinating blueberries, the flower is twirled between thumb and finger to discharge pollen onto the thumb nail. The stigma of the receptive flower is then touched with this pollen

From his experience, Dr. Coville concluded that the most effective plan for breeding was to make crosses of only the most superior parents and raise large numbers of seedlings from them. 'Blueray' (and also 'Bluecrop') was one of 1,250 seedlings of the cross.

Actual crossing in the greenhouse is easy and rapid. Pollen is collected on the thumb nail or in a dish by twirling the open flowers between the thumb and forefinger. The stigmas are touched with the pollen-covered thumb nail or brushed with a camel's-hair brush dipped in pollen. The flowers need not be emasculated in the greenhouse for rarely does a blueberry ever set seed without hand pollination. The flower to be pollinated is turned to one side so as to avoid shaking and mixing pollen from the flower itself on the thumb nail.

Seed is easily cleaned from the ripe fruit by putting up to about a pint of blueberries in water in a Waring blender and turning on the current for about 40 seconds. The good seed sinks to the

bottom and the pulp can be decanted off. The seed is then surface dried and stored in a refrigerator until sowed.

The seed is sowed on shredded sphagnum moss in flats—1,000 or more seed to a flat, in winter—and the seedlings potted in 2- to 2½-inch bands when 2 to 3 inches high. By October they are 12 to 24 inches high and are ready to be set in the field. They fruit in 2 to 3 years, when first selections can be made. Row tests of the selections are then made and finally a few named.

Since Dr. Coville's retirement and until 1957, the writer continued the blueberry breeding much as Dr. Coville had done—selecting, testing, and naming the best of the seedlings. No highbush varieties have been named, resulting from crosses made since Dr. Coville's retirement, but many selections are being tested for possible naming and four rabbiteye varieties for the South have been named.

The chief additions and changes in the work over the years have been (1) raising even greater numbers of seedlings of promising crosses, (2) using the 'Ashworth' (a native highbush selected in northern New York) for extreme hardiness, (3) surveying and classifying (W. H. Camp) the native blueberry species as a basis for including more species with added horticultural characters in the breeding program, (4) crossing the best selections of the rabbiteye of West Florida and Southern Georgia for southern varieties, (5) crossing (with R. H. Sharpe of the University of Florida) native Florida selections for varieties for low chilling requirement for the extreme South, (6) making artificial tetraploids by crossing hexaploid x diploid to utilize characters in them in crosses with tetraploids, (7) crossing for resistance to blueberry canker in North Carolina by further use of native resistant selections, and (8) greater care in propagating blueberry selections to avoid infection with virus diseases.

With so many species having so many desirable qualities to be utilized, the blueberry promises to have a long, long story and to become even more useful both for its fruit and as an ornamental.

To obtain clean seeds, berries from hybrid plants are placed in a Waring blender with water for 40 seconds. After the pulp is decanted, seeds are filtered out and dried

Seedlings planted in a nursery are tested for plant and fruiting habit, fruit quality and productivity. Desirable plants are labelled and kept for further observation

PROBLEMS IN BREEDING FOR DISEASE RESISTANCE

An appraisal of the difficult pursuit of immunity to disease

Robert N. Stewart

THE use of resistant varieties has been recommended as the solution to many plant disease problems. The appeal of this approach is obvious to growers and gardeners, who often wonder why plant breeders don't act upon the recommendation and develop resistant varieties. For many years, breeding for disease resistance has been a major part of plant pathological and breeding programs for most of the important crop plants. Results from this type of research have enabled large areas of our agriculture to prosper and often to survive as the result of the introduction of new disease-resistant varieties.

The successful programs have many features (objectives, techniques, etc.) in common, and each has many facets requiring considerable resources to support the research. World-wide collections of cultivars of crop plants and their wild relatives and progenitors have been made and these collections have been screened for hereditary factors for disease resistance. Areas where important diseases are indigenous are searched for races or varieties of the crop species that may have become resistant through natural selection. A search is also made to determine the number and geographic distribution of races which the pathogen (disease organism) has been able to produce and which might spread upon introduction of a susceptible cultivar. Finally, in testing for disease resistance, adequate consideration must be given to the pathogen, its potential for variation, and the effect of environmental conditions upon its virulence and the host plant's susceptibilities.

Most, if not all, attempts to breed for disease resistance in ornamental plants have been on a rather limited scale and have not been entirely successful. The reasons vary and consideration of several specific cases will show some of the factors involved.

In 1934, S. L. Emsweller and H. A. Jones, working at the University of California, reported that resistance to rust in snapdragons was controlled by a single dominant factor and that modifying complementary factors allowed selection of immune plants from resistant parents. Their data recorded natural infection in the field and thus only relatively local sources of rust were involved. In 1937, C. E. Yarwood, of the California Agricultural Experiment Station, found a race of snapdragon rust that infected the resistant cultivars mentioned above. Apparently this new race had not been present earlier in the area where Emsweller and Jones had performed their tests. C. O. Blodgett and G. A. L. Mehlquist, then also at the California Agricultural Experiment Station, inoculated 140 different species and cultivars of the commercial snapdragon with the two known races of rust and found no commercial cultivar immune from both races although some were resistant. Seven distantly related species of *Antirrhinum* showed some resistance, but most were susceptible.

Thus an apparently simple solution to a disease problem by development of a resistant variety was not a complete solution because of variability of the pathogen. Statements have appeared in the literature that most of the fungal

pathogens of ornamental plants are fairly stable and that resistant varieties continue to be immune. However, as more breeding programs explored the variability of disease organisms, more and more of them were found to be differentiated into numerous races on the basis of host range or pathogenicity as well as in several other respects. Most notable are the wheat rust studies, which have uncovered some 240 parasitic strains or physiologic races of stem rust and 140 of leaf rust.

In ornamental plants, perhaps the most startling report is that of W. R. Jenkins on *Diplocarpon rosae*, the fungus causing blackspot of roses. Working at Beltsville he studied the susceptibility of a host spectrum of 20 different roses to 22 single-spore isolates of *D. rosae* from 17 different geographical areas. He found that each isolate was a different pathogenic race, *i.e.*, that each infected a different group of the 20 rose species and cultivars. The existence of races of the pathogen affords a reasonable explanation for the frequent instances of a new rose proving resistant to blackspot in the originator's fields but susceptible in at least some areas around the country. To be usefully resistant to blackspot, a rose must be resistant to all races of the causal fungus present in all the important rose-growing areas. Each race of a disease is a separate problem to the plant breeder as resistance to each generally has a separate genetic basis.

The origin of the variability of pathogens is the same mutation process that is the basis of variability and the evolutionary process in all organisms. The various types of vegetative nuclear associations and disassociations found in the life cycles of many fungi as well as the segregation of chromosomal and genetic material which occur in sexual reproduction give ample opportunity for all possible aggressive forms of the pathogen to appear and have their chance to burst into rapid asexual reproduction if a suitable host is present.

Another example of the difficulties in breeding for disease resistance can be pointed out in carnations. About 1950, several carnation cultivars were introduced by the Waltham Field Station, of the University of Massachusetts, as resistant to fusarium wilt, a soil-borne vascular disease caused by *Fusarium oxysporum* f. *dianthi*. These carnations had been tested by inoculation with a mixture of cultures of this fungus from several separate isolations made in Massachusetts. Tests at Beltsville confirmed the resistance of these cultivars to a race of the pathogen isolated from the Boston area. However, they proved susceptible to races from several other parts of the country. In the New England area, they were susceptible to bacterial wilt, another soil-borne vascular disease of carnations whose symptoms are often confused with those of fusarium wilt. The fact that these cultivars were resistant to a few of the many races of the fusarium wilt fungus that attack carnations proved of little value to commercial carnation growers and these cultivars have disappeared from the market.

As the first step in a program at Beltsville of breeding for resistance to the two vascular wilt diseases of carnations, every available cultivar of carnation and *Dianthus* species and variety were collected. At the same time, plants affected with fusarium wilt and bacterial wilt were gathered from the important growing areas in the United States and pure cultures of the disease organism were isolated from each. An extensive screening program has been carried out for the past five years exploring the host range of the isolates of the pathogens among the species and cultivars of *Dianthus*. We have found that there are many different pathogenic races of each of the two disease organisms. Furthermore, the resistance which enabled us to differentiate the races has been found in small bits, *i.e.*, resistance to a single pathogenic race in a single

To obtain varieties of potatoes which are resistant to virus and other diseases, U. S. Dept. of Agriculture plant breeders are crossing our best commercial varieties with varieties from other countries, and even with wild species from South America. The first step in making a cross is to gather stamens from plants which are to be the male parents

host variety. Wide-spread resistance to a number of races was not found.

We have concluded that at this time it would not be practical to breed carnations resistant to all races of the fusarium wilt or the bacterial wilt organism. Until sources of more wide-spread resistance or immunity are found it would probably be impossible to combine resistance to all existing pathogenic races and keep ahead of the pathogens in finding and incorporating resistance to the new races that are surely forming.

The possibility of breeding for resistance to rose blackspot is being explored. The number of different races reported by Dr. Jenkins is discouraging, but the fact that the species roses used in his

After pollen from the anthers of the stamens is shaken out onto the thumb nail, the stigma of the intended seed-bearing parent flower is rubbed over with the pollen

The true seed of potatoes is born in clusters of fruits that look like tiny green tomatoes. Cut open they reveal small seeds which, when sown, will produce potato plants

University of Wisconsin photos

tests were resistant to so many races of the disease organism is encouraging. We are now doing more work on the occurrence of pathogenic races and their geographical distribution, studying methods of keeping cultures of the disease organism viable and virulent over a period of years, standardizing an artificial inoculation technique by using detached leaflets in the laboratory under controlled conditions, and gathering and testing roses from every source.

In contrast to the relatively simple genetic basis for rust resistance in snapdragons, that for resistance to fusarium wilt in asters is apparently complex. Several programs, notably those of L. R. Jones and A. J. Riker at the Wisconsin Agricultural Experiment Station, and of K. F. Baker at the California Agricultural Experiment Station at Los Angeles, have produced wilt-resistant aster cultivars. The inheritance of this resistance was not stabilized, and it was necessary for seedsmen to continue rather expensive breeding and inoculation procedures to maintain resistance.

Constant selections among single-plant lines must be continued under conditions of heavy infestation of soil with the aster wilt fungus and favorable environmental conditions. This selection obviously sacrifices many plants and greatly reduces seed yield. Thus, resistance seems to be basically an economic problem. There is no clear-cut evidence of pathogenic races of the causal fungus of the kind described above for the rose blackspot and carnation wilt organisms, but different isolates have varied in their degree of aggressiveness or the speed and severity of infection. To select truly resistant plants, it has been necessary to have maximum soil infestation with aggressive races of the wilt fusarium and optimum soil temperature. Resistant cultivars of aster, which were developed under these conditions, were resistant in all the geographical areas in which they were tested, indicating at least that they were not being exposed to different pathogenic or more aggressive races.

Resistance to disease may be the result of one or more of many factors or interactions of factors affecting the structure and physiology of the host plant and its interaction with the environment. Thus the method of inheritance is often very complex. The resistance to one disease is usually inherited by a genetic system independent of resistance to any other disease. Resistance to each different race of any disease is usually inherited independently of resistance to other races. Several genes may each give a different degree of resistance to a single race of the disease organism but a single gene seldom confers resistance to more than one pathogenic race. The plant breeder working on disease resistance thus faces the general problem of incorporating new genes into commercially acceptable types of plants. The selection in each generation is more difficult than in many other types of breeding. Two biological entities must be maintained and their reactions to environment held as constant as possible to measure accurately their interaction, the resistance of the host to the pathogen.

A successful breeding program must use the widest possible array of variants of both the host and the pathogen to select the most resistant forms of the first and expose them to the widest possible range of races of the latter. As either of these two facets of a breeding program is reduced, the probabilities of widespread adaptability and long-lived usefulness are also reduced. One must further face the fact that the pathogens are constantly changing. Mutations followed by hybridization and segregation are constantly forming new races. A planting of a resistant cultivar is an efficient screen in which a new race capable of parasitizing the resistant cultivar would be caught. Thus the goals of the breeder for disease resistance are constantly moving on and for the most part he can only hope to keep a few jumps ahead of the parasite by an ever-continuing breeding program.

BREEDING DISEASE-RESISTANT CHESTNUTS*

An appraisal

EVER since the chestnut blight fungus was discovered, the search for American chestnut trees possessing natural resistance to the disease has been going on, but so far the outcome of this work has not been encouraging. Highly resistant trees have not been found; the best has been a small number of partially resistant sprouts. These sprouts have been used in the development of hybrids.

The chestnut breeding program in Connecticut had its beginning in 1931 when, under the sponsorship of the Brooklyn Botanic Garden, the first hybrid nuts were produced on Japanese trees on Long Island, N. Y. The pollen for these hybrids came from a large old American chestnut near Washington, D. C., being furnished by the then office of Forest Pathology of the United States Department of Agriculture. The seedlings from these nuts were set out on the Sleeping Giant Plantation at Hamden, Conn., which since 1947 has been under the management of The Connecticut Agricultural Experiment Station.

These first Japanese-American hybrids appeared very promising both in their erect form and rapid growth. But it soon became evident that they were only partially blight resistant—in fact, in this respect they were intermediate between both parents. Further breeding would have been impossible had it not been for the inarching method of grafting suckers developing below blight lesions on the trunk into healthy bark above the lesions.

Since these early crosses were made a large number of hybrids have been developed. The most important parents are: *Castanea dentata,* the American chestnut; *C. crenata,* the Japanese chestnut; *C. mollissima,* the Chinese chestnut; *C. sativa,* the European chestnut; *C. henryi,* the Chinese timber chinkapin; *C.*

Although one parent of this so-called 'Essate' x Japanese hybrid chestnut is the bush-size common chinkapin (*Castanea pumila*), this hybrid has good growth form and is highly resistant to blight fungus

Conn. Agricultural Experiment Station

* Abstracted from Circular 192, "Blight Resistant Chestnuts" by Hans Nienstaedt and Arthur H. Graves, Connecticut Agricultural Experiment Station, New Haven, Conn.

seguini, the Seguin chestnut; and *C. pumila*, the common American chinkapin. Several promising hybrids are now being tested. The best is the so-called CJA, a cross between the Chinese chestnut and selected first generation hybrids between the Japanese and American chestnut. Although there is considerable variation in the CJA crosses, they include what seems to be a sufficient number of desirable trees to make their planting as a forest tree worthwhile.

Another hybrid which has some promise combines Chinese and American chestnuts. These hybrids are primarily of two types: one combines the form of the American parent with intermediate resistance; the other shows more Chinese characteristics, being highly resistant but of poor form. Only rarely do the trees combine high resistance with a good growth form. Considerably more breeding will be needed before this hybrid can be used for timber production.

While most of the better hybrids have the Chinese chestnut, the most resistant of the exotics, as one parent, there are a few in which this species has not been used. The so-called Essate-Jap, of the combination ((*C. crenata* x *C. pumila*) x *C. crenata*) x *C. crenata*, especially, has possibilities as a forest tree; it rates high in resistance and the form is relatively good. Much improvement, however, will be needed before it can be put out in forest plantings.

A limited amount of breeding toward good orchard type trees has been done in Connecticut and one good hybrid has been developed. It combines the prolificness of *C. seguini* with a high degree of resistance from *C. mollissima*. Its nut is of medium size and of excellent flavor and texture. Unfortunately it is not entirely winter hardy in Connecticut, a trait it inherits from its Seguin parent. After further field testing it may be useful as an orchard and home garden tree at a more southern latitude.

No discussion of chestnut breeding in the United States, however brief, would be complete without mentioning the work done by the United States Department of Agriculture at the Beltsville Experiment Station in Maryland. The work there has been centered around the Chinese-American hybrid and its backcrosses to the Chinese parent. Some very promising hybrids have been developed.

To keep diseased chestnut trees (*Castanea dentata*) alive for further breeding, it is often necessary to graft vigorous shoots (growing from the base) into the trunk above the diseased areas on the lower trunk

NEW TREES ARE ON THE WAY

Trees for the forest as well as the home—hand pollinating vs. letting nature do it

Jonathan W. Wright

WE plant improved varieties of corn and zinnias. Why not of trees? As a matter of fact, new trees are on the way. Over 100 agencies in the United States, Europe, Japan, Australia, and other countries are engaged in tree improvement research. Most of the emphasis is on pines, poplars, eucalyptus, and larches. However, a score of other genera are receiving minor attention.

What about the time element? Will it take centuries to obtain these new trees? Not necessarily. For one thing, our present forest trees are unimproved forms and we can make rapid progress by skimming the cream from the top of inherently variable wild populations. For another thing, we can start several projects, one after the other, and have a steady inflow of results once the initial 10- to 20-year waiting period is past. In a good many cases we can see important differences in two- or three-year-old seedlings.

Racial Variability In Trees

Racial tests offer the quickest way of improving the average quality of planting stock. Consider, for example, Scotch pine *(Pinus sylvestris)*. It has a tremendous natural range, extending from Spain to Turkey in the south and from Scotland and northern Scandinavia to eastern Siberia in the north.

There is a planting in southern New Hampshire which shows just how variable this species can be. This planting was established in 1938 with seed from 55 different localities in Europe. It was measured in 1955 when the trees were in their eighteenth year. At that time trees grown from northern Scandinavian seed were only 6 feet tall whereas trees grown from Belgian seed were 23 feet tall. Think of it—almost a 4 to 1 difference in growth rate! That was not all. The Scandinavian trees were straight whereas a very high per cent of the trees originating from Belgian, German, and Czechoslovakian seed were crooked. In the autumn nearly all the trees grown from some of the seedlots turned yellow, whereas trees from other origins such as Belgium and Germany, remained blue-green. The trees of Latvian origin, which grew about 19 feet tall in the 18-year period, had straight stems, and remained green until Christmas time, seemed to be the best for the average tree planter.

White ash (*Fraxinus americana*), which is native in most of eastern United States, is another racially variable species. Trees from the northern part of the range—Maine to Wisconsin—are relatively slow-growing and winter-hardy. The southern race—from Maryland to southern Indiana and southward—is inherently much faster growing but when planted in the north loses most of its extra growth because of winter killing. In this species there are racial differences in several other characters such as summer leaf color, fall leaf color, pubescence, chromosome number, and type of root system.

We have been indifferent to this matter of seed source and have planted trees of whatever origin was most convenient. In some species, such as red pine (*P. resinosa*) and Norway spruce (*Picea abies*), we have lost relatively little in the way of growth rate or tree form because of inattention to seed source. But in Scotch pine we're paying a serious price for our indifference—the plantings of the mid-1930's are producing only a fraction of the usable wood which could have been produced

if every planting had been of the proper seed source. Fortunately this situation is being corrected, and many growers now order seed from specified sources.

Species Hybrids

Work done at the Northeastern and California Forest Experiment Stations during the past 35 years has uncovered many interesting and potentially useful species hybrids in pines. One of these, which is of great interest to us here in the northeast, is the cross between eastern white pine (*P. strobus*) and western white pine (*P. monticola*). In preliminary California nursery tests this cross outgrew seedlings of either parent species by more than 25 per cent. The same margin of superiority has been evident in southern Michigan tests. Although this particular hybrid has not been tested as yet for weevil resistance, we have high hopes. The western parent is only 20 per cent as susceptible as the eastern parent. With their rapid growth the hybrids should prove very useful in New York and Pennsylvania even if they are only intermediate between their parents in weevil resistance.

Eastern white pine also crosses with several other species such as Himalayan white pine (*P. griffithi*) and Mexican white pine (*P. ayacahuite*). Both of these crosses were made in Philadelphia about 10 years ago and in both cases the hybrids outgrew their parents by more than 25 per cent in nursery tests.

Tree hybridizers have devoted much attention to the genus *Populus*. Serious work started 35 years ago when the late A. B. Stout and his then-student, E. J. Schreiner, used the railroad to shuttle back and forth between New York City and Rochester to get their hybrid seed in the ground while it was still fresh. Within a matter of a few years they produced hundreds of thousands of hybrid seeds, and thousands of living hybrids involving 99 different combinations between species. These were all outplanted in Maine, and the best have been tested at several places in this region. In these test plantations it is not uncommon to find such combinations as eastern cottonwood (*Populus deltoides*) x European black poplar (*P. nigra*) growing 30 feet tall in five years.

In the Po Valley of northern Italy these eastern cottonwood x European black poplar hybrids have almost displaced the pure species. The American parent was introduced there many years ago. Because it hybridizes so easily with the European species, hybrid swarms have been formed in many places. Most of the poplar nurserymen turn to those hybrid swarms as sources of cutting stock for their nursery propagation work.

We are all familiar with the story of hybrid corn—how it is higher yielding than open-pollinated varieties and how corn grown from hybrid seed should not be used as seed because the F_2 progeny are often weak and variable. We suspect that most tree hybrids will react the same—that we shall have to make the first generation hybrids anew each time we plant rather than relying on F_2 seed collected from the original hybrids. Fortunately this does not pose a serious problem. All the species combinations mentioned in this paper are easily produced. In time we will find economical mass production techniques. The same is true of a great many other promising hybrid combinations.

Selective Breeding

Selective breeding involves combing the forest for superior trees, collecting seed from those trees, and testing the seedlings under uniform conditions. Then the best single trees are chosen from among the best progenies (a progeny is the offspring of a particular individual or cross between selected individuals) and the whole process is repeated.

This method is being used for the production of a blister rust-resistant variety of western white pine in northern Idaho. That disease is wreaking havoc with the white pines of that region, threatening the destruction of all stands which have not been protected

by the pulling of *Ribes* bushes (wild and cultivated currants), the alternate host of this disease.

Work on the new variety was started in the late 1940's when a few dozen absolutely rust-free trees were chosen—after several hundred miles of walking—and crossed with each other. The resulting progenies were grown in a nursery for two years, then outplanted in their permanent locations. Both the nursery and outplanting were artificially inoculated with blister rust to reduce the number of "escapes" to a minimum.

Even at this early date success of the project seems assured. The trees were measured when five years old and at that time more than 30 per cent of the trees in some progenies which resulted from crossing selected parents were rust-free. This compares with an average of 5 per cent resistant seedlings in the progenies of unselected parents. In a few years the permanent test planting will start to produce cones. It will be thinned at that time and will become a seed orchard for the mass production of a new, partially resistant variety of white pine.

The pure mechanics of artificial pollination is difficult. Most trees produce their flowers high in the crowns. That is where the controlled pollination work must be done. Thus during the pollinating and seed collecting seasons a tree breeder is primarily a tree climber. A great many fellows consider this a minor problem. In the spring they get "baggitis," a desire to climb and tie bags on flowers whether or not controlled pollinations are needed. As a matter of fact, on trees of moderate heights, such as we have in this region, the climbing is usually a pleasant (but always a dirty) task. The fact that tree flowers are borne high off the ground is troublesome in another respect, however. They have never been studied with the care given buttercups or roses. The tree breeder must be his own expert, learning those details which would be common knowledge for a great many herbaceous plants.

This 17-year-old Scotch pine grown from Latvian seed illustrates the potentialities of this species in the Northeast

These Scotch pines were grown from seed collected in Germany and illustrate the dangers of using seed from the improper geographic origin

USE OF COLCHICINE IN PLANT BREEDING

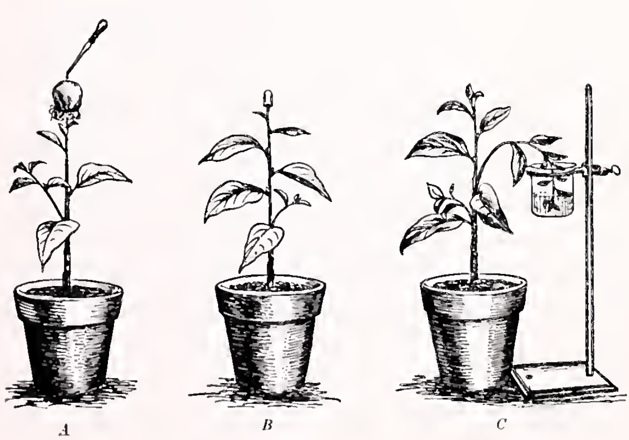
Samuel L. Emsweller

THE chromosome number of many plants has been determined and in some genera the chromosome numbers of the species vary in an arithmetical series. In chrysanthemum the basic (haploid) chromosome number is 9 and species with 18, 27, 36, 54, 72, and 90 chromosomes are known.

In gladiolus the basic chromosome number is 15 and Bamford (1)* found wild species with 30, 45, 60, 75, 90, 120 and possibly 135 chromosomes. The garden cultivars are tetraploid, with 60 chromosomes. So far no gladiolus species with 105 chromosomes has been found.

The polyploidy in chrysanthemums and gladiolus has probably existed for some time, having occurred spontaneously during the evolution of the various species of these genera. There is now evidence that spontaneous doubling of chromosomes occurred recently in narcissus, iris, and poinsettia. When the daffodil cultivars 'King Alfred' and 'Van Waverens Giant' were introduced commercially, it was not known that they were tetraploids. The basic chromosome number in narcissus is 7, and older varieties were practically all diploids, with 14 chromosomes. In iris, Randolph (5) found that practically all cultivars introduced from 1840 to about 1910 were 24-chromosome diploids. In 1942 and 1943 the chromosome numbers of 109 new cultivars were determined; 108 were tetraploid and 1 was a triploid. In poinsettia several commercial cultivars recently introduced were found by Ewart and Walker (3) to be tetraploid. They had appeared as unusual branches on diploid plants and were propagated

* See references at end of article.



Methods of applying colchicine solution to stem tips of older plants. A, growing tip covered with cotton which is kept moistened with colchicine solution. B, growing tip covered with half of a gelatine capsule containing colchicine dissolved in a soft agar jelly. C, growing tip immersed in colchicine solution in a vessel supported by a ring stand. After Avery, Thomson, *et. al.*, "Hormones and Horticulture"

because they were considered an improvement over the parent cultivar.

Colchicine is a drug that has been used for centuries as a specific for gout. It occurs in the fall-blooming crocus, *Colchicum autumnale.* In 1937 Blakeslee and Avery (2) and Nebel (4) reported the successful doubling of the chromosome number of various plants by means of colchicine. This discovery made it possible to double the chromosome numbers of species, and induced tetraploids have been reported by many investigators. In general, tetraploids have larger flowers, borne on stockier plants. In most instances the tetraploids flower later and produce fewer flowers than the diploids from which they originated.

Induced polyploidy is useful in plant breeding in some instances where otherwise it is impossible to obtain hybrids between species with different chromosome numbers. For instance, a plant with 20 chromosomes may not cross with another with 40 chromosomes, but when made tetraploid, it may prove cross-fertile. There are also instances of sterile hybrids being made fertile by doubling their chromosome number. The chromosomes of the two parents of the hybrid may be able to cooperate in forming a hybrid, but may not be able to pair in meiosis and form functional pollen grains or egg cells.

Tetraploidy has been induced in several species of plants by treating seeds, stems, and other plant organs with colchicine. The important thing is to treat a growing point or region where cells are actively dividing. If colchicine is in a cell when it is dividing, the separation of the two halves of split chromosomes is delayed and the cell fails to divide. The daughter halves of each chromosome eventually separate and remain in the same cell, which now has twice as many chromosomes as before. If such a cell produces a branch it will be tetraploid.

At Beltsville, tetraploidy has been induced in several species and cultivars of lilies by soaking bulb scales in aqueous solutions of colchicine. The scales form adventitious bulblets and if colchicine is present in a cell that forms a bulblet, the latter may be a tetraploid.

Colchicine, which is soluble in water, has proved effective in a wide range of concentrations. Concentrations as low as 0.01 per cent have induced chromosome doubling in the Easter lily. The highest frequency of tetraploid bulblets was obtained on lily scales treated with 0.2 per cent colchicine.

The colchicine solution may be applied to seedlings by means of an eyedropper. The colchicine should be applied directly to the growing point of the seedling. A penetrating agent, such as Tween 20, may help to get rapid penetration of the colchicine. A few drops of the penetrating agent added to a tablespoonful of colchicine solution is ample. The treatment of seedlings may be repeated for several days to insure presence of colchicine when the cells are dividing.

Colchicine usually gives seedlings or plant tissues a shock and retards growth. It is always advisable to leave some plants untreated as a check. If the drug is effective, the leaves of treated plants usually are thicker and coarser, and the stomates are larger. It is usually possible to recognize affected seedlings by the characteristics mentioned.

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RADIATION GENETICS AND CROP IMPROVEMENT

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WE have become accustomed to thinking of the tremendous destructive force of the atom bomb as the beginning of atomic energy. However, geneticists have been using X-rays (one form of atomic energy) for more than a quarter of a century for producing hereditary changes in plants. In 1927 and 1928 it was shown by Dr. H. J. Muller, then at the University of Texas and now at Indiana University, and the late Dr. L. J. Stadler of the U.S. Department of Agriculture and the University of Missouri, that X-rays would produce, in abundance, genetic changes in both plants and animals. Muller X-rayed male fruit flies (*Drosophila*) while Stadler X-rayed seeds of barley and maize. This was the beginning of radiation genetics.

The science of Radiation Genetics very early crossed the Atlantic and became international. In Sweden, research workers were interested in trying to use atomic energy to produce new and better types of crops.

In the spring of 1928 the late Dr. Herman Nilsson-Ehle, then Director of the Swedish Seed Association at Svalof and Head of the Genetics Institute of Lund University, was contacted by Ake Gustafsson, one of his students and now at the Forest Research Institute, Stockholm. Gustafsson proposed to embark on evolutionary (and also revolutionary) study of agricultural plants by means of X-ray and ultraviolet induced mutations. The basic idea was that if nature continually produces mutants of value for the species, it should be possible to produce them experimentally as demonstrated by Muller and Stadler.

Nilsson-Ehle and Gustafsson found many chlorophyll mutations in barley by the use of X-rays. In the middle thirties, Nilsson-Ehle discovered some mutants characterized by dense heads and very stiff straw. Some strains had higher yields than the parental strains, also definite ecotypes for high and low nitrogen fertilizer, strains shorter and taller than the parent, also earlier and later strains.

Plant breeders in the United States began experiments following the war when isotopes became plentiful and the use of radiation sources more common. An outstanding development of this has been a higher yielding strain of peanuts, also peanuts resistant to leaf spot developed by Dr. Walton C. Gregory, of North Carolina State College at Raleigh. Another landmark has been the development of rust-resistant strains of oats by Calvin F. Konzak of Brookhaven National Laboratory and by K. J. Frey, of Iowa State College, at Ames. At Brookhaven we have changed a white carnation to red by radiation, and also developed a White Sim variety of carnation with no flecks of red.

Dr. Ingvar Granhall, at the Balsgard Fruit Breeding Institute in Sweden, has been using chronic gamma radiation in comparison with X-rays, fast neutrons, beta rays and thermal neutrons in the study of somatic mutations in fruit trees. Although his Co^{60} source the first year was only 2 curies (increased last year to 20 curies) he has been successful

in producing genetic changes in fruit trees.

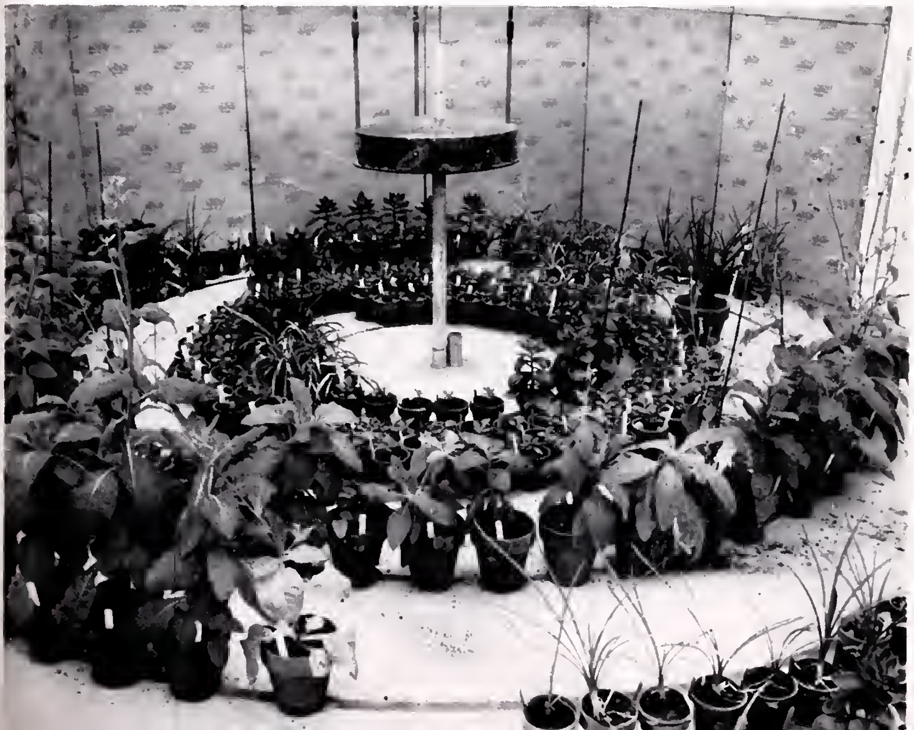
Great differences in sensitivity to radiation are manifest as the pollen of corn develops from its initiation (in the course of "meiosis") to the time it is shed. By growing plants in pails in "the portable corn field" it is possible to expose them at any desired stage in pollen development. It has been demonstrated that almost, but not quite, mature pollen is the most sensitive stage for the production of mutations. This occurs in corn about a week before pollen shedding. If other plants have similar sensitive periods, the desired mutations can be secured by exposing plants for a short time—one day or less. Hence the radiation field can be used much more efficiently for producing mutations in many more plants, thereby facilitating the work of the plant breeder.

Radiation genetics is becoming an increasingly cooperative undertaking. At Brookhaven, for example, dozens of universities and agriculture experiment stations send seeds to be exposed to neutrons in the nuclear reactor, or plants to be exposed to gamma rays from the 1800 curie source of cobalt 60 in the field.

The Brookhaven Gamma Radiation Field

The primary purpose of the gamma field is to promote basic research in plant radiobiology. Plants are being studied with a view to understanding the nature of mutations, chromosome

Plants growing in the gamma radiation greenhouse at Brookhaven National Laboratory, Upton, N. Y., are arranged in concentric rings around the radioactive Cobalt 60 source, which is in the pipe extending into the floor. The source can be raised or lowered by remote control. While the source is up, the plants receive a continuous dosage of gamma radiation, which varies in intensity depending upon the distance from the source. When the source is down in its protective shield below the concrete floor, the greenhouse can be safely entered. Behind the source is a shielding wall, which protects the plants in the adjoining greenhouse from the radiation. This facility is part of Brookhaven's program in the study of the effects of radiation on plants, some of which result in interesting and often useful mutations



Exposure of this white carnation plant to gamma rays caused a genetic change in color so that a red carnation appeared on the middle stalk. Cuttings grown from the stalk having the red flower gave a plant which produced all red flowers. In this way, the red flower can be propagated indefinitely but it is doubtful if the seed from this flower would breed true

aberrations and other forms of radiation injury (for example, in snapdragons, petunias, corn and tobacco). All these kinds of changes increase in number with increasing doses of radiation. Studies on factors which affect sensitivity to irradiation have been made on a large number of species of plants, and such plants as evergreen and fruit trees, lilies, cereals, tobacco and chrysanthemums are currently being studied. Some of the factors found to be important are: chromosome size, chromosome number, chemical composition of plants, age of plant, and growth rate. Tumor formation in plants is being studied in certain tobacco hybrids. Tumors in these plants occur spontaneously, and the number can be increased greatly by irradiation. The nature of the tumor-promoting action of the radiation is being investigated.

Brookhaven also operates a somatic mutation program in cooperation with a number of universities and agricultural experiment stations. One of the objectives of this program is to induce useful mutations. Among the plants growing in the gamma field for this purpose are apples, peaches, grapes, strawberries, blueberries, roses, snapdragons and carnations. Some of the more promising mutations found are: early and late ripening peaches; changes from freestone to clingstone peaches; three new carnations which are soon to be released to the trade; and some interesting mutable genes in snapdragons.

The 10-acre gamma field at Brookhaven National Laboratory has an 1800 curie cobalt-60 source which emits gamma rays. The field is exposed continuously to these rays for 20 hours out of every 24. The dosage at 2 meters from the source is approximately 10,000 roentgens (r) per day, at 10 meters 480 r per day and at 20 meters 120 r per day. Gamma radiation does not make the plants radioactive.

Aerial view of the gamma radiation field at Brookhaven National Laboratory, in the center of which is a source of radioactive cobalt which gives off gamma rays

SHORT HISTORY OF HYBRID CORN

With personal reminiscences

Henry A. Wallace

THE history of hybrid corn in the United States begins with Professor Beal of Michigan State University at East Lansing and is summarized on a plaque on the campus there which reads in part as follows—"Near this spot in 1877 Beal became the first to cross-fertilize corn for the purpose of increasing yields through hybrid vigor. From his original experiment has come the Twentieth Century miracle—hybrid corn."

Where did William James Beal, the beloved Professor of Botany at Michigan State from 1870 to 1910, get the idea? Partly, at least, from Darwin with whom he corresponded. In 1876 Darwin had published the book "Cross and Self Fertilization in the Vegetable Kingdom." In it is a very short description of an exceedingly small experiment with the inbreeding of corn vs. the cross breeding. Beal had come to esteem Darwin because he had studied botany under Asa Gray, the close friend of Darwin. Thus Darwin's tiny experiment blossomed in Michigan. By present-day standards the Michigan experiment was small but it cast a long shadow into the future and should be a continual stimulus to all research workers.

In passing we should say that Darwin got many of his ideas about the superiority of plant hybrids from a long line of British, French and German workers with fruits, vegetables and flowers. Private plant and animal breeders furnished much of the "soil" in which many of Darwin's ideas came to fruition.

At Michigan State in Beal's day were a number of men who later had a profound influence on the agriculture of the Middle West. Among these was P. G. Holden who studied under Beal and who was brought to the University of Illinois in 1895 or 1896 by Dean Eugene Davenport (also a Michigan State man much interested in breeding) to work on corn breeding under a chemist by the name of C. G. Hopkins.

Holden started inbreeding corn in 1896 after determining that the most promising corn to work with was Reid Yellow Dent. He crossed the inbred strains, observed the hybrid vigor and took pictures of the hybrid corn as compared with the inbred corn. Unfortunately for Holden, Hopkins did not like him. So Holden left and his preliminary work was destroyed.

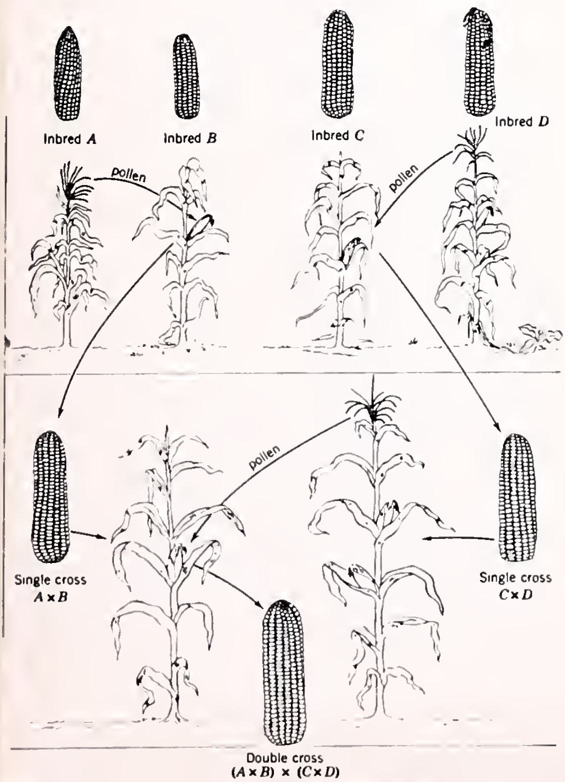
In 1902 my grandfather was one of those who helped pay Holden's salary so he could be Director of Extension in setting up Iowa's first extension service. Holden used to visit in our home when I was a high school boy and was responsible for my planting a five-acre field of corn in 1904 where I pulled the tassels out of every other row. The rows were planted an ear to the row and I harvested seed only from the detasseled rows to sell at \$5 a bushel (rag-doll tested ear by ear for germination). I sold 10 bushels. This was not hybrid corn in the true sense of the word but Holden's enthusiasm created an open mind for what came later.

Holden also created in me a critical faculty because he gave me his judgment as to which ears he thought would yield best and suggested that I plant them the following year on an ear to row basis and weigh up the product to see whether or not his judgment was correct. The following fall I learned that Holden's top ear was among the bottom ten. Later on Holden established

many corn yield tests in Iowa which became the precursors for tests which made possible the rapid introduction of hybrid corn.

I mention this about Holden because so few people give him any credit whatsoever and because he is still living, well past the age of 90. His failure to follow up what he had learned ten years before East and Shull may be attributed partly to Hopkins' dislike of him and partly to the fact that he was more interested in the people who grew corn than he was in the corn itself.

The customary history of hybrid corn begins with Dr. E. M. East of the Connecticut Experiment Station at New Haven. Of course, East had actually started under Eugene Davenport and Hopkins at Illinois in 1900 but he had run up against some of the same things in Hopkins' chemical mind as had Holden earlier. Fortunately for East, a most remarkable man who had been trained at Yale (Dr. E. H. Jenkins, head of the New Haven Station), recognized a good scientist when he saw one. East had inbred corn at Illinois in 1905 and continued it when he came to New



Haven in 1906. Out of these inbreds started at Illinois and continued at New Haven came the crosses that created much of the intellectual climate under which hybrid corn later thrived.

I first met East in 1919 and came to have a great fondness for this intense irascible man. In 1924 at the Institute for Politics at Williamstown, Mass., Dr East and Dr. O. E. White of the Brooklyn Botanic Garden ran one of the round tables in which I participated. As a result I became very fond of this most unusual human being, a man who was vivified by science, not desiccated.

Actually, aside from Holden, my own interest in hybrid corn derives from Dr George H. Shull who had begun inbreeding corn the same year as East. Shull began describing the results of crossing the inbreds earlier than East. I saw one of Shull's papers while I was still a student at Iowa State College. That is why I started a little inbreeding work in 1913. But my really intense interest did not begin until I read some of the accounts of the Connecticut work by Donald F. Jones and visited with Fred Richey of the USDA in Washington in 1920. Richey and Jones had far different temperaments but I found them both most interesting to be with.

Jones, Richey, Shull and East, as well as H. K. Hayes, who had been trained in the East tradition all made tremendous contributions to the foundation of hybrid corn during the first two decades of this century. Jones clearly formulated the idea of the double cross using four inbreds* instead of either two

*The combination of four inbred strains gives the right amount of genetic diversity, *i.e.*, *homeostasis*, which makes possible the development of varieties that can be grown over very wide areas. This is essential for the large seed companies who are selling seed in tremendous quantities to be grown in many different regions.—ED.

Illustration at left shows how four inbred lines of corn are double crossed. This method is used to improve the yield. (*Reprinted by permission from Dobzhansky, "Genetics, Evolution, and Man," John Wiley & Sons, Inc., N. Y., 1955*)

or many inbreds. Actually in sweet corn today they use only two inbreds or sometimes three in order to get maximum uniformity.

Oftentimes I have wondered what would have happened if the commercial corn breeders had not been stampeded into the double cross. For example, a very small increase in yield of the single cross over the double would have paid for the extra cost of the seed, several times over. Sometimes commercial people, in order to cater to consumer prejudices having to do with seed appearance or to save a dollar or so a bushel in cost of seed, will do that which they know is not the very best in the long run for the farmer. I do not criticise; I merely make a passing comment on human nature. We strive for the better, not always for the best. The consumer is the guide. But is he always right?

I visited several times with Dr. Shull who did his work at the Carnegie Institution at Cold Spring Harbor. He engaged in double crosses of inbreds before Donald Jones but he was like Holden in a sense—he did not see the commercial implication. Shull was as different from East as day and night. His temperament was careful, precise and plodding. While my own initial inspiration came more from Shull than East, I can see why East inspired a far larger number of students than Shull. It is not always the one who is first and most precise with a scientific idea who helps the world more.

[It was Shull who pointed out for the first time that inbreeding makes possible the selection and fixation of superior germ plasm. This is the great contribution that Shull made basing his observations on the work of Mendel and Johannsen. It is questionable whether East fully appreciated this important point. Today most of our hybrid corn is made with a very few inbreds that have been selected from many hundreds of thousands of inbred lines. The Indiana WF9 that is mentioned here is used to produce about half of the hybrid corn grown throughout the world.—Donald F. Jones]

When my father became Secretary of Agriculture in March of 1921, I immediately urged on him the idea of replacing C. P. Hartley, the head of Corn Investigations, with Fred Richey. C. P. Hartley was another of those who had inbred corn before either East or Shull but he had not formulated the significance and he thought chiefly in terms of every farmer saving his own seed. (In those days it had been found by experiment that on the average a farmer could get 10 to 15 bushels more to the acre from his own seed than if he bought it from a seedman.) Instead of building up a new system of corn breeding operating through corn seedsmen, Hartley wanted to operate through the farmer himself, using methods which the ordinary farmer could understand. I sympathized with Hartley's approach but I knew Richey was in step with the future and my father agreed with me. During the early twenties Richey, as head of Corn Investigations for the USDA, was of inestimable value in coordinating the work of the various people inbreeding corn at the different experiment stations. He was responsible for setting up the corn inbreeding work at the Iowa Experiment Station and starting the Iowa corn yield test on its way. This yield test, which was an outgrowth of the thinking fostered originally by the Holden yield tests 15 years previously, gave scientific validity for the first time in a *really big* way to the fact that hybrid corn was definitely superior to open-pollinated corn.

During the twenties I wrote hundreds of articles on hybrid corn in "Wallace's Farmer." For a time I tried to cultivate the idea that certain farmers in each locality could learn to use the inbred strains originated at the experiment stations. I tried to interest many farmers' sons. Finally I became convinced that it was no use trying to salvage a remnant out of the old Hartley idea and founded the first seed company specifically for the purpose of

producing hybrid seed corn. This was in the spring of 1926. From the very beginning we produced our seed by drying all our ears from the detasseled rows down to 12 per cent moisture during late September, October or early November, by means of hot air and a fan. We thus broke with what had been almost universal practice of drying out the ears separately and rather slowly. Today 99 per cent of the seed corn of the U.S. is produced by a modification of this hot air-fan forced method.

During the early twenties I learned that good inbreds for the Middle West had to be developed under Middle West conditions out of Middle West corn. This is almost but not quite a universal rule. From a Midwest point of view James Holbert, an Indiana boy who worked for the USDA on ground furnished by Eugene Fung of Bloomington, Illinois, did even more than Fred Richey under whom he worked for 13 years. Richey may have had more theory but Holbert was working with Midwest corn under Midwest conditions and, therefore, he was almost certain to get more good inbreds than Richey working back at the Department Farm at Arlington, Virginia. Jenkins, the Oregon boy who worked for a short time under Holbert and later supervised the inbreeding work for the Federal Government at Ames, Iowa before he became head of all USDA Corn Investigations, had the advantage of working with several strains of Reid Yellow Dent (first brought to prominence by Holden) as well as Richey's great favorite Lancaster Sure Crop from Lancaster County, Pennsylvania.

About the time Merle Jenkins was discovering good inbreds in Iowa and Holbert was discovering them in Illinois, B. H. Duddleston of Purdue in Indiana, inbreeding corn on Wilson Farm near LaFayette, produced what he called W(ilson) F(arm) 9. This inbred out of Reid Yellow Dent has been more widely used than any other inbred corn in the whole world. I am glad to mention Duddleston because his name is so rarely heard. He was one of those boys who worked out in the hot sun during those long July days. Duddleston worked under a botanist by the name of G. N. Hoffer who had an insight into corn possibilities not possessed by the Farm Crops people at Purdue, who had to think about show corn. Hoffer realized that corn might have ideas of its own and that these might be different from the rationalizing of a corn judge. I was always drawn to Hoffer because I had found out the same thing myself.

Duddleston left Purdue for Cornell and R. R. St. John took his place. It was St. John who really spread WF 9 far and wide. It was St. John who teamed up with Charles Gunn, a practical farmer in DeKalb, Illinois to put the genetic foundation under the DeKalb Seed Co. St. John knew the Indiana inbreds and Gunn, who had worked very closely with Holbert before Holbert left the Department to go with the Funk Seed Company, knew all that Holbert knew plus a lot he had found out for himself. While the DeKalb people did not sell any seed until the winter of 1934-35, they went with great speed thereafter.

Lester Pfister, an Illinois farm boy who has been extensively written up in connection with hybrid corn, is a spiritual descendent of Holden via Mosher and myself. Mosher had run corn yield tests for Holden back in 1905 to 1910. In fact, in the fall of 1906 I helped Mosher harvest one of Holden's yield tests and saw the enormous differences in yields of different farmers corns. About 1912 he became the first County Agent in Clinton County, Iowa and there he conducted a very extensive yield contest lasting several years. This work was so impressive that he was hired by Woodford County, Illinois to do the same kind of work. As a result of three years of yield testing it was found that Krng corn was the highest yielding of more than a hundred sorts. It had actually yielded as a three-year average 10 bushels to the acre more than the corn which had won prizes consist-

ently at the Chicago International.

When I went over to El Paso, Illinois to see this remarkable work of Mosher, I found that his right-hand man was a tenant farmer with a high school education by the name of Lester Pfister. For a time Pfister was quite sure that Krug corn was better than any hybrid. He was staying in my home in 1923 or 1924 when he confessed to me he was wrong. As a matter of fact, I think he had already begun to inbreed Krug corn. One of his sorts known as K 187 has a beautiful dark green leaf and has been widely used. Because of his training by Mosher, the kind of training inculcated by Mosher, Holden and Beal, Pfister really studied his corn plants in the field. The botanist Beal was speaking through Pfister, the very practical plant breeder.

I have just scratched the surface in this brief presentation. My own hybrids did quite well in the Iowa Yield test. In 1933 I left for Washington and others took up where I left off. For a time the company I founded sold practically all the hybrid seed in use. But beginning in 1935 many companies were selling seed. The use of hybrid seed went up until by the middle forties nearly 100 per cent of all corn planted in the central corn belt was hybrid. Great emphasis was placed on stiffness of stalk and as a result of stiff-stalked hybrid corn, corn picking machines became really practical for the first time.

Today it is possible to produce a half billion more bushels on 75 million acres than were produced in the old days on 105 million acres. Perhaps half the increase is due to cheap nitrogenous fertilizer. Hybrid corn seems to yield 30 per cent more per acre than the old open-pollinated corn. Under some conditions it will yield 50 to 60 per cent more and under other conditions only 10 to 15 per cent more. Nobody ever explained these variations.

The increased yield of corn in Europe due to the use of hybrid seed now amounts to about $100 million a year. In the U.S. at a dollar a bushel, the value of the increase is nearly ten times that.

Connecticut Agricultural Experiment Station

A seed production field in which all of the seed parent plants have been detasseled

NEW VARIETIES—
HOW TO LOOK AT THEM

Carlton B. Lees

WHAT about new varieties of iris, roses, peonies and lilies . . . just what makes them good? Why is this year's hemerocallis better than a variety of yesteryear? Actually, not all new varieties are complete improvements in all characteristics. A new rose, for instance, may possess spectacular color, but if form, vigor, hardiness, fragrance and all other characteristics are not good, it has little value in itself. For the plant breeder, of course, it can serve as a step to something better. He will attempt to keep the excellent color while breeding into the variety the other good characteristics until he arrives at one superior in all things. The following are qualities to look for in a new flower and ways to appraise them.

Color

Cleanliness is the word which is most important in evaluating color. Be the color brilliant or subtle, hot or cool, it should above all else be clean and refreshing. Even where one color seems to overlay another, such as in some bearded iris, the effect should still be clean and free from all traces of muddiness.

Somehow, color should be suited to the flower of which it is a part. This is a difficult characteristic to ascertain because it is too easy to be influenced by what we think an iris or rose or lily should be, and this in turn is influenced by what they have been. For example, so-called pink iris are relatively new, yet it seems that this color is so delicate and subtle in its relationship to pink and orange that it is entirely suitable to the fragile delicacy of the flower itself. It is difficult to think of a scarlet iris because scarlet—the color of "Red Emperor" tulip—is not at all a delicate color and seems entirely unsuitable. It is necessary to admit, however, that should scarlet appear in iris, the very structure of the flower itself, which allows light to pass through the fragile tissues and thus through the pigment, might so change the color as to make it suitable.

Flowers do have character which results from a combination of color, substance (body of the tissues) and form. Hence we have the richness of a rose, the crispness of delphinium, the twinkling quality of daylilies, the intense heat of red-orange lilies and the purity of whites and near whites, the freshness of a peony, the explosiveness of dahlias. Color to be good should support and emphasize form.

Form

Form is a sculptural quality; it has to be viewed from several points. While a flower may come into better focus from a given point of view, it still should hold up well to inspection from all angles.

Not only does the form of the flower itself enter into consideration, but the manner in which it is borne on the stem, the stem on the plant and so on. If the flower-bearing stem is leafless and rises from the foliage, such as that of daylily or iris, then it should be clean of line, strong but not cumbersome, and pleasingly proportioned to both flowers and foliage. Some daylilies, for example, have such pleasing flower, stem and foliage relationship, that a good sized cluster with five or more stems can be satisfying from a sculptural point of view alone. This would be lost, of course, if flower stems were too short

or too long, the flower clusters too heavy or too sparse, or the foliage short and spiky instead of elegantly fountain-like. These are subtle but nevertheless real characteristics which must come into the evaluation of any new variety.

In cases where flower-bearing stems are also leaf-bearing, such as in roses and peonies, the relationship in space between flower and foliage becomes important on each stem as well as the manner in which stems go together to make the whole plant. The leaves should not be all bunched up on the stem immediately below the flower, neither should they be so far down that the flower is on a long goose-neck of a stem.

When considering form, it is too easy to confuse geometric or mechanical perfection with beauty. The Greeks were smart enough to mechanically (and mathematically) distort the facade of the Parthenon so it would look right. We don't always see things as they are, and for a flower to appear to have pleasing form is more important than its having measurable perfection only to appear uninteresting.

Fragrance

This is an old-fashioned and often considered sentimental virtue of older varieties of many kinds of garden plants, but just go a year or two without your sense of smell, then you suddenly realize how important it is in the enjoyment of a garden. A garden should sharpen all of the senses: seeing, (obviously!), hearing (birds, water), touching (a rugose leaf, a waxy smooth one), tasting (dill, mint) and smelling not only the sweetness of nicotiana, but sun on azalea leaves, the headiness of basil. Let's not be sold short on fragrance!

Habit of Growth

Growth habit is responsible to a great degree for the over-all form of the plant, so the two cannot be too distinctly separated. Here, however, we are concerned more with biological analysis than with aesthetic: sturdiness, substance, vigor, insect and disease resistance, hardiness, longevity and so on. While these are the more mundane characteristics, they are no less important because they give support and strength to the aesthetic ones.

Sturdiness: ability to stand up well in the garden through wind, rain, hot sun. Even color might be considered as possessing sturdiness if it does not fade as the flower ages.

Substance: related to sturdiness except that it has to do with the plant tissues rather than the plant as a whole. Good substance is variable. In a rose, for instance, the petal tissue should be thick and suggest the pile of velvet. In a lily, the petals should be thick, smooth and often glossy or waxy. Iris standards should be thin and delicate but should be crisp enough to stand up well with no hint of being limp.

Vigor: does it grow fast enough to produce a good sized plant in a reasonable period of time? No variety should be so vigorous that there is danger of its becoming a weed or difficult to control.

Resistance: the ability to withstand, or even being immune to, insects and diseases is becoming increasingly important in the breeding of new varieties of all kinds of plants.

Hardiness: can it withstand the rigors of winter? Not only is sheer cold a factor, but even more important in many cases is the ability to withstand the wide fluctuation of winter temperatures.

Longevity: gardeners are impatient with perennials which are inherently short-lived.

Seeing New Varieties

It is important to take advantage of the opportunities to see new varieties of various kinds of garden plants and make note of those which are most appealing. Botanic gardens, endowed garden centers, and other display gardens which are open to the public, offer excellent opportunity to see newer varieties. Many commercial growers welcome visitors during bloom season, so this gives another opportunity to see

many varieties at once. Be sure to keep the notes too, because the varieties which continually appear to be good year after year probably are very good.

Bulletins and other publications of the various plant societies are also rich with information about varieties new and old. Since they are constantly being evaluated by members, it is wise to take advantage of the experience of the experts.

The many shows which are staged by national, regional and local plant societies offer yet another source of information about varieties. It is amazing how often a certain variety of rose, gladiolus or daffodil comes through to win top honors. Often this winning ability has no relationship to the age of the variety or to its price. Quality is what counts and some varieties simply produce better quality flowers more consistently than others. It must be remembered, however, that top show varieties are not necessarily top garden varieties.

Varieties

To help in evaluating several kinds of garden plants, the following lists have been compiled with the help of amateur and professional horticulturists. This is an attempt to point out a few well-known varieties which have been landmarks in the development of the flower. In some cases they are still as good as, or better than, many newer varieties of their kind. In others, the newest ones surpass them but are still not generally known, not easy to find, or are expensive.

In a way, then, this list attempts to define quality by giving specific examples—it in no way is intended to be the "five or ten best" list for each kind of plant. These varieties can be used as standards of sorts; if a variety doesn't compare favorably to some of these, then its quality might be considered questionable.

Roses

Charlotte Armstrong	(HT)
Crimson Glory	(HT)
Frau Karl Druschki	(HT)
Peace	(HT)
Betty Prior	(F)
Fashion	(F)
New Dawn	(CL)

Lilacs

Mont Blanc (white)
Ellen Willmott (white)
De Miribel (violet)
President Lincoln (blue)
Decaisne (blue)
Lucie Baltet (pink)
Ludwig Spaeth (purple)
Mrs. W. E. Marshall (purple)

Daffodils

King Alfred	(T)
Queen of the Bicolors	(T)
Beersheba	(T)
Carlton	(LC)
Fortune	(LC)
Daisy Schaffer	(LC)
Selma Lagerlof	(LC)
Edward Buxton	(SC)
Lady Kesteven	(SC)
Cheerfulness	(D)
Inglescombe	(D)
Thalia	(Tr.)
Geranium	(Tz.)
Actea	(P)

Peonies

Festivia Maxima (E.D.)
Edulis Superba (E.D.)
Lady Alexandra Duff (M.D.)
Felix Crousse (M.D.)
Grace Loomis (L.D.)
Milton Hill (L.D.)

Key to abbreviations. **Roses**—HT, hybrid tea; F, floribunda; CL, climber. **Daffodils**—T, trumpet; LC, large cupped; SC, small cupped; D, double; Tr., triandrus; Tz., tazetta; P, poeticus. **Peonies**—E.D., early double; M.D., midseason double; L.D., late double; M.Jap., midseason Japanese; S., single. **Dahlias**—FD, formal decorative; ID, informal decorative; SC, semi-cactus; IC, incurved cactus.

In daffodils, breeders strive, among other things, to perfect the form of the flower so that it has the sculptural quality evident in this flower (variety 'Dulsie')

Roche

When a gladiolus variety will consistently produce strong stalks having attractively shaped, neatly arranged flowers, then it is considered of high quality (variety 'Gold')

Mikado (M. Jap.)
Le Jour (S.)

Hemerocallis

Lady Bountiful
Mission Bells
Ruffled Pinafore
Naranja
Mabel Fuller
Salmon Sheen

Iris

Spanish Peaks
Desert Song
Ola Kala
Argus Pheasant
Solid Mahogany
Happy Birthday
Dreamcastle
Master Charles
Sable
Blue Rhythm
Pierre Menard

Dahlias

First Lady	(FD)
Kidd's Climax	(FD)
Five Star General	(FD)
Clariam Forever	(ID)
Windlassie	(ID)
Michigan White	(SC)
Brother Justinius	(SC)
Surprise	(SC)
Prairie Fire	(SC)
Bertha Shone	(IC)

Gladiolus *

Florence Nightingale
Lorelei
Gold
Elizabeth the Queen
Friendship
Picardy
Red Charm
Apple Blossom
Orange Gold
Fort Knox
Burma

* This is a difficult list to establish because gladiolus seem to flash across the garden like meteors and quickly pass from usage.

Daffodils—A Review and Preview

(*Continued from page 35*)

Actually, what motivates British breeders is largely rivalry for honors and distinction on the show bench. I do not belittle in any way the splendid work of such men as Guy Wilson or Lionel Richardson. I am one of their greatest admirers. Just the same it is a strange hobby to raise and collect daffodils so nearly alike that even the experts can hardly tell them apart.

Daffodils selected by show-bench standards bear no relation to the daffodil as a garden plant. Just take the list of names of introductions of thirty, twenty or ten years ago and see how very few of them exist in current catalogs. Then look at a well-grown 'Emperor' (1865), a well-grown 'Firetail' (1910) or a 'John Evelyn' (1920), and you will realize how little real progress there has been.

The Dutch breeders, meanwhile, were influencing the selection in a different direction, for they had the further objective of tapping the huge greenhouse and florist market.

Thus, the popularity polls conducted by the R. H. S. reflect a gradual divergence between show, florist and garden daffodils.

At this time in the history of the cultivated daffodil, we stand at a crossroad. In the lines of breeding practiced in England and Holland today we see little progress. Daffodils should not get bigger; they should not get more refined and sculptural; certainly they should not get any less adapted to garden conditions. If we look toward the next hundred years and wonder what daffodils then will be, we come to a startling conclusion—the daffodils of the future may have to come from an entirely different line of breeding.

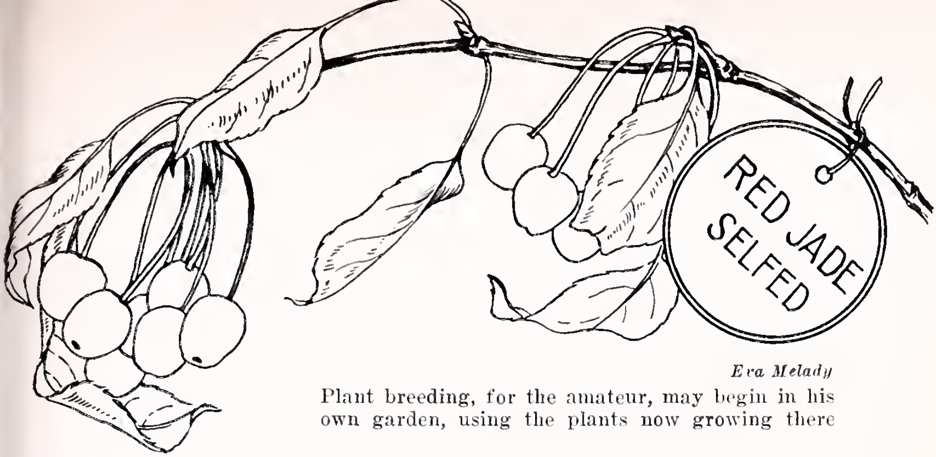
What must we do? We must look at the daffodils that do well in our gardens; exploit their good characteristics and try to preserve them in new seedlings. We must do our hybridizing in the climate where we want to raise and grow daffodils. We must put a different group of people to work.

Let us look, for a moment, at the varieties that naturalize well—'February Gold', 'Helios', 'Trevithian', all jonquil and triandrus hybrids. Most of these are sterile varieties, they set no seed; the bulb does not exhaust itself in seed production. Hence, *by that little margin* the varieties do a little better than other, more fertile ones. *By that margin they survive* where others perish. Now why are they sterile?

The modern daffodil is a tetraploid; cross it with primitive species, most of them diploid, and the result is a group of triploid seedlings. It is these triploids that do not set seed. Here in one simple genetic trait lies already part of the answer to the quest for better garden daffodils. Resistance to basal rot, so obviously present in the polyanthus types, is carried on in all their seedlings. The "cut and come again" quality is also a genetic factor transmitted to seedlings.

My recipe, then, for new daffodils for our country is not to continue along the lines of the classical show daffodil. It is to seek, by crossing the outstanding varieties in the garden with the wild species, new lines, new types, that through our different climatic and human influence will play a role in our American gardens.

I need only point to some of such new varieties that have already appeared. 'Silver Chimes' is finding a ready acceptance in the South—it should be more widely grown. A Dutch poetaz called 'Geranium' was one of the most successful flowers in large scale trials in Southern California. Some crosses of big trumpet varieties with *N. bulbocodium* gave us amazingly vigorous daffodils that in trials in the St. Louis area gave every evidence of having merit. New crosses of poetaz with jonquils gave me some fine new polyanthus types; jonquils with *N. triandrus* gave us a series of fine daffodils. And one need only see the many lovely, new miniature daffodils to realize that much can yet be achieved.



Eva Melady

Plant breeding, for the amateur, may begin in his own garden, using the plants now growing there

A THOUGHT TO OUR FUTURE ORNAMENTALS

Russell J. Seibert

THE present generation constantly demands something new, and better. Design is of ever-increasing importance in America's way of life. We see this expressed in clothing, in new automobile models, buildings, home appliances, even in gardens and a few improved plant materials.

The key to new and better plant cultivars is the practical plant breeder who is basically trained in the fields of genetics, horticulture, botany and has a feeling for the likes and dislikes of the public.

The improvement of agricultural crops has of necessity demanded the talents of most of our younger trained geneticists and plant breeders, while ornamental plants, in all but a few limited groups, have gone begging or are left to the dedicated amateurs.

I feel that the dedicated amateur is showing us the demand for "new design and new models" in ornamental plants. One need only see what has been done with lilies, daylilies, African violets and bromeliads just in the last few years to realize the potential which exists among many genera of ornamental plants. Many woody plants and slower growing perennials are somewhat more difficult to improve and take a longer time to show results than do annuals. Nevertheless they present tremendous possibilities for the future. Already a few people with vision toward future trends are well on the way to making names for themselves and their institutions. Among those more difficult long-range improvement programs one might cite the potentials being demonstrated in hollies, camellias and magnolias. A classic departure from the usual type of breeding program is tailor-making California native plants into suitable ornamentals for Southern California conditions.

Every year hundreds of new ornamental plants are brought into this country to help satisfy the American public's demand for something new and different. Every year I feel we are missing the boat by not encouraging more talented students here to venture away from the particular interest of their professors and into that wealth of wonderful plants which are the raw materials for new design, new models and a new high in American horticulture.

MEANINGS OF TERMS USED IN PLANT BREEDING

Apomixis. When a plant produces seeds it usually means that the normal course of sexual reproduction has preceded it, *i.e.,* pollination, fertilization, etc. Sometimes, however, as in the common dandelion (*Taraxacum officinale*), seeds develop without this sequence of events. This may occasionally happen in almost any plant. The phenomenon is called *apomixis.* Apomixis may take place in several ways. Sometimes egg cells develop without normal meiosis, so they are diploid without uniting with a sperm cell. These diploid eggs may develop into embryos. In other cases certain cells of the ovary other than egg cells may for some obscure reason act like fertilized eggs and develop into embryos. Offspring produced by apomixis are genetically identical with the female parent. See p. 82.

Basic number of chromosomes. This phrase is used only when there is a polyploid series in a particular group of plants. It refers to the number of chromosomes in the gametes (sperm or egg cells) of a diploid plant. For example, in the genus *Gladiolus* diploid species with 30 chromosomes produce gametes with 15 chromosomes. There are also triploids with 45 chromosomes, tetraploids with 60, pentaploids with 75, etc. In this case 15 is the basic chromosome number for the series.

Chimera. Plants whose tissues are of two or more genetically different kinds, giving rise to spontaneous abnormal characteristics, such as leaf variegation on an otherwise green-leaf plant, stems which are half one color, half another, or plants bearing flowers of two or more different colors. These changes may result from hybridization, X-ray treatment, or may originate at the point of union when a plant is grafted.

Chromosomes. Microscopic bodies found in the nucleus of every living cell, whether plant or animal. The chromosomes are the bearers of the hereditary units (see *gene*), and it is through them that offspring inherit the characteristics of their parents, grandparents, etc.

Chromosome numbers. Each kind of plant and animal has a characteristic number of chromosomes per cell, *e.g.,* man has 48, cabbage 18. In the cells of most flowering plants (and in most animals) the chromosomes are in duplicate sets, one of each set being contributed by each parent. Plants having such duplicate sets of chromosomes in each cell are said to be diploid. In the formation of sex cells, during meiosis, the sets of chromosomes are separated, so each sex cell gets only one complete set. Such cells are haploid. For example, one species of gladiolus, *Gladiolus cardinalis,* is diploid, with 30 chromosomes per cell (two sets of 15 each). Its eggs and sperms have only 15 chromosomes per cell, so are haploid. In some plants there are more than two sets of chromosomes in each cell. Plants with such multiple sets of chromosomes are said to be *polyploid.* This condition is rather common, especially among cultivated plants. A polyploid with three sets of chromosomes is called a *triploid* (*e.g., Gladiolus formosus* with 45 chromosomes); a polyploid with four sets is a *tetraploid* (*e.g., G. primulinus* with 60), and so on.

Clone. Collective term referring to all the plants ever produced asexually from one single plant, *i.e.,* by rooted cuttings, division, grafting, etc. Since sexual reproduction is not involved, all the offspring are identical with the original parent in their hereditary constitution. For example, all 'Peace' variety roses constitute a clone.

Compatible. Said of two plants that are capable of being crossed together successfully to produce seeds.

Diploid. See *chromosome numbers.*

Dominant. If a plant carries genes for both red and white flower color but produces only red flowers, the gene for red is said to be dominant over the gene for white (see *recessive*).

F_1. The first filial generation, *i.e.,* the offspring of a given set of parents.

F_2. The second filial generation, *i.e.*, the offspring of the F_1's produced by cross-fertilizing (among themselves) or self-fertilizing them.

Fertilization. The joining together of two gametes, *i.e.*, the sperm and egg, to form a cell called a fertilized egg or zygote. This cell develops into the embryo plant.

Gamete. A reproductive cell of either sex, *i.e.*, sperm or egg.

Gene. The "units of heredity" which are passed on from one generation to another in the sperm and egg cells. Genes are not visible but are known to be located in the chromosomes. They control size, form, color and all other qualities that are inherited by offspring from their parents.

Genetics. The branch of science concerned with the inheritance of characters by offspring from their parents.

Haploid. See *chromosome numbers*.

Heterozygous. Since most plants are diploid, genes for a given character are present in duplicate. If the two genes for a particular character are not identical, for example, if one of the genes for flower color is for red color and the other for white, the plant is said to be heterozygous for that character Thus, a red-flowered plant with "hidden" white is *heterozygous*.

Homozygous. If both genes for a given character are identical, for example, if both genes for flower color are for red (or both for white, as the case may be), the plant is homozygous for that character.

Line Breeding. A plan of inbreeding in which descendants of a desirable ancestor are crossed, their offspring again crossed, etc.

Meiosis, Mitosis, see pp. 14, 15.

Mutant. In horticultural language a mutant is a "sport." It arises as a result of spontaneous change in one or more genes. For example, a branch on an apple tree might produce fruit with taste and other qualities that are different from the rest of the fruit on the tree. This particular branch would be a "sport" or mutant, and can be propagated by grafting or taking cuttings.

A young plant grown from seed may (in one of thousands of germinating seeds) be markedly different from its parents and sister plants. If this change is inherited in future generations, such a plant, too, is considered a mutant. Treatment with various kinds of radiation or certain chemicals, such as colchicine, may induce mutation.

Parthenocarpy. Formation of seedless fruit without fertilization. It occurs regularly in banana, pineapple and seedless grapes.

Parthenogenesis. Development of an egg into an embryo without fertilization. It is one type of apomixis (which see).

Polyploid. See *chromosome numbers*.

Recessive. A genetic character which is not visible in heterozygous plants. The gene for a recessive character is hidden but not altered by the presence of its corresponding dominant gene. See *dominant*.

Reduction Division. See *meiosis*.

Species. This term is very easy to illustrate, but unusually difficult to define. In broad terms it might be said to mean all of the individual plants (or animals) that are alike in all important characteristics. For example, if one could look at all the roses which grow wild in the world, certain ones would be found to resemble one another so closely that they could be said to be the "same kind." These would be one species, perhaps *Rosa setigera*, the prairie rose. In like manner other groups of roses could be selected, such as *R. centifolia*, the cabbage rose, *R. odorata*, the tea rose, and so on. While these species of roses differ from one another, they all have certain characteristics in common which enable us to recognize them as "roses." Such similar species can be lumped together in a larger group called a *genus*, in our example the genus *Rosa*, rose.

A scientific name consists of the genus name (a noun) followed by the species name (an adjective), thus, *Rosa* is the genus name, *odorata* the species.

Tetraploid. See *chromosome numbers*.

Triploid. See *chromosome numbers*.

Zygote. The fertilized egg, resulting from the union of egg and sperm.

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BROOKLYN BOTANIC GARDEN

PLANTS & GARDENS

HANDBOOK ON BULBS

EW SERIES
ol. 15, No. 3

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Acknowledgments

Sketches of bulbs in this Handbook, except as noted below, were drawn by Eva Melady from live material as it appears in autumn.

Drawings on pages 5, 7 and 9 are from "Flowering Bulbs for Canadian Gardens," by R. W. Oliver.

PLANTS & GARDENS

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Editorial

R. W. Oliver, *Guest Editor*

Paul F. Frese, *Associate Editor*

and the Editorial Committee of the Brooklyn Botanic Garden

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Gottscho-Schleisner

Daffodils naturalized near water have the quality of poetry in motion

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES
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Autumn 1959

Many thoughts come to mind as I contemplate the numerous kinds of plants that are loosely called "bulbs." In terms of evolution, and the millions of years that the earth has been home to living things, plants have come to thrive in every environment—in water, soil, and in the air. Some climb, others crawl. Some have roots that grow into the dark soil, others are perched in trees, or move with the tides. In short, plants of one kind or another have found a satisfactory life—whatever the circumstances. A few, perhaps three thousand species in all, *have gone underground with their buds.* These are the plants we know as bulbs, the subject of this Handbook.

In parts of the world where hot, dry summers and lack of rainfall—or the freezing temperatures of winter—make growth temporarily impossible, bulbs lie quietly in wait for better days ahead. Anyone who, at the right season, has visited the countries around the Mediterranean or gone further into the Middle East, has seen wild species of tulips, narcissus, and crocus in bloom. In the dry lands of South Africa, callas grow wild; and in the woods of the northeastern United States and southern Canada, *Erythronium* (dogs-tooth violet or trout-lily) carpets the forest floor in early spring.

In a sense, a bulb behaves like a seed. Each has its own little warehouse of stored nutrients, and the potential to grow into a new plant. If conditions are not favorable for growth, it may lie dormant for many years—during which it is alive, but in a state of "suspended animation." No one knows how long certain bulbs might live under such circumstances, but a friend who knows well the deserts of South Africa once told me that the bulbous plants, ensheathed in their dry scale leaves, might wait for years for adequate rain, then grow. Thus can a bulb carry a species through years of adversity.

Call bulbous plants one of the many curious manifestations of evolution, a part of nature's great design, or what you will, the fact remains that in them man has found a great companion. He has hybridized them into thousands of garden varieties that have followed the trade routes of the world and brought color, cheer, wonderment and vital beauty to gardens everywhere.

Not through oversight but because of the limitations of space, a few of the well-known bulbous wild flowers have been omitted; many of them are native in the northern states and in southern Canada. It seemed more important here to include bulbs that are perhaps less familiar, but are available in the trade.

If the scientific names occasionally seem formidable, think nothing of it. Most bulbous species "come that way;" the scientific name is frequently also the common name.

We are proud to add this Handbook on Bulbs to the Botanic Garden's series. Guest Editor Oliver and the authors he has invited to contribute to the book offer readers the best information available in Canada and the United States. May its 96 pages and nearly 200 illustrations bring pleasure and enlightenment to all who discover it.

Sincerely yours,

George S. Avery

Director

Watson from Monkmey

Large, firm bulbs of the Chinese sacred-lily (*Narcissus tazetta* var. *orientalis*), ideal f forcing indoors in pebbles and water

JUST WHAT ARE BULBS, CORMS AND TUBERS?

R. W. Oliver

ALTHOUGH this is a handbook on bulbs, it includes many plants which grow from structures classed botanically as corms, tubers and rhizomes. There is a clear structural difference between these classes that plays an important part in their culture, method of storage and particularly in their propagation.

A true bulb is a dormant, rounded underground stem with a growing point or bud in which next season's plant is present in embryo form. If a tulip or daffodil is cut through vertically, at time of planting, even the segments of next year's flower can be seen. The embry is surrounded by fleshy scales or laye of storage tissue that hold enough foo to supply the growing plant until th green leaves unfold sufficiently to assum responsibility for food production. Th storage tissue is often wrapped tightl around the bud, as in daffodils and tulip or it may take the form of separat scales loosely attached, as in the lil In either case the union between bu and storage tissue is through the bas plate, which is really a modified stem.

Roots develop from the underside c

TYPES OF BULBS

True Bulbs

DAFFODIL

LILY

Corms

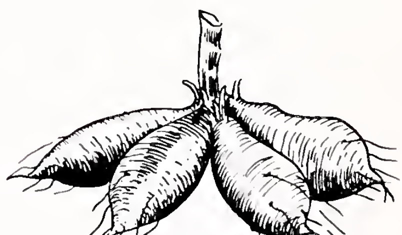
CROCUS

GLADIOLUS

Tubers

BEGONIA

Tuberous Roots



DAHLIA

Rhizomes

IRIS

McFarland

By carefully splitting a mature hyacinth bulb in half, the embryonic flowers are revealed, surrounded by fleshy scale-like leaves. Thus the entire hyacinth bulb is, in effect, a dormant bud

around the edge of the base plate soon after the dormant bulbs are planted in the earth in the fall. New bulbs develop from smaller buds which occur on the base plate between the food storage scales, just as growth buds occur on the stem of a shrub or rose in the axils of the leaves. Usually there are one or two of these buds in a bulb, so that increase is by gradual division, as in the daffodil or lily. Sometimes several appear, in which case the terms "splitting" or "multiplication" are used.

A corm is a solid mass of storage tissue on the top of which there are on or more growing points which are usuall visible. On the underside, there is a bas plate from the edge of which the root develop.

The storage tissue shrivels as th plant grows. After it blooms, new corm are built up on top of the base plate o the old corm.

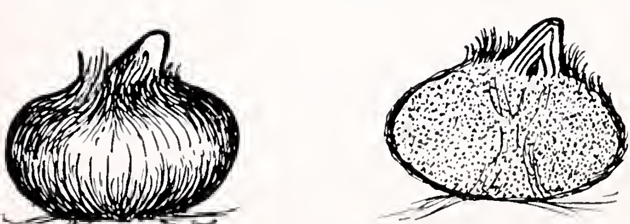
Additional increase is by the forma tion of small "bulblets" or "cormels" o the roots or around the base plat Crocus and gladiolus are common ex amples.

A tuber is also a solid mass of storag tissue but it does not have a base plat There are growing points or "eyes" fro which the shoots and roots develop. A growth of the plant continues, the tube may diminish in size as does the potat forming new tubers on the roots of th new plant; or it may increase in siz as in the tuberous begonia. Increase i by the natural production of new tuber as in the dahlia, or by cutting the ol tuber into pieces, each of which possess a bud or "eye," as in the begonia o potato.

A rhizome is a thickened undergroun stem made up of storage tissue, as i canna or Solomon's-seal. Stems and leave rise from buds on the upper side whil roots develop from the lower side.

New plants are propagated by cuttin the rhizome into sections, each possessin one "eye."

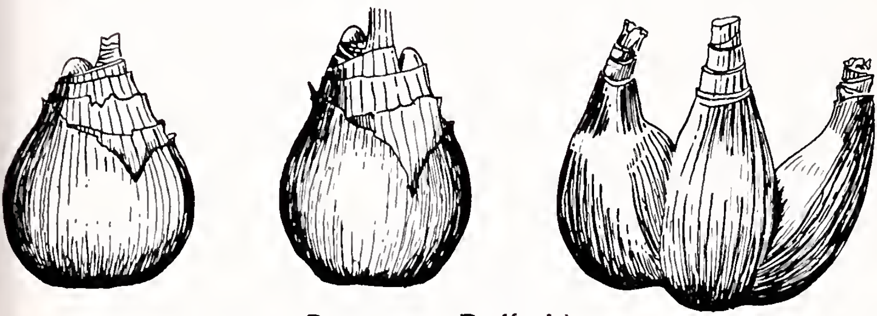
Thus it is that various types of "bul ous" plants have food storage capacity t tide them over some period of enforce dormancy. In the North this is i winter; in the South during periods o drought.



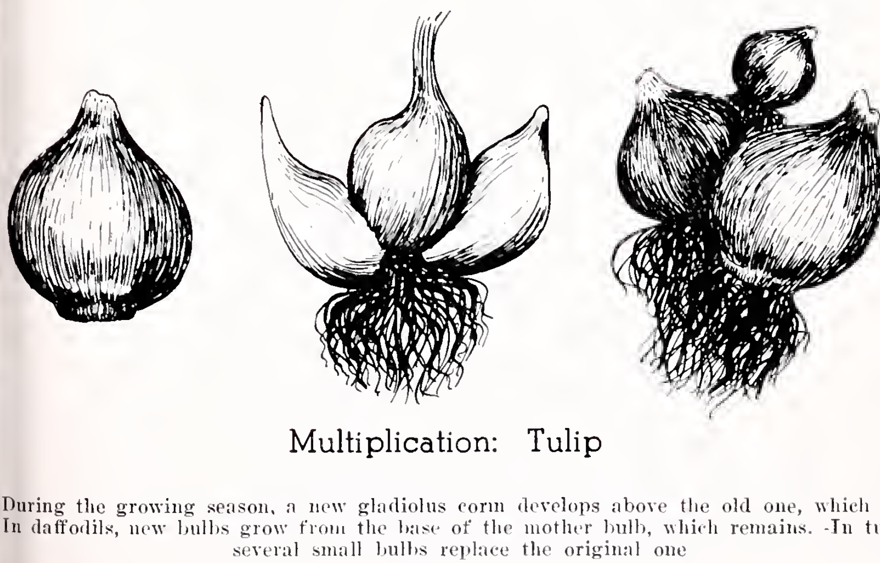
The crocus corm is fleshy storage ste covered with an out husk (left); the di gram of a cut sectio (right) shows that th dormant bud is at th top of the corm onl

METHODS OF REPRODUCTION

Cormels: Gladiolus



Division: Daffodil



Multiplication: Tulip

During the growing season, a new gladiolus corm develops above the old one, which dies. In daffodils, new bulbs grow from the base of the mother bulb, which remains. In tulips, several small bulbs replace the original one

THE TYPES OF BULBS

Grouped according to the way they are grown

FOR general purposes, bulbs may be divided into two classes, (1) hardy bulbs that should be planted outdoors in fall in temperate or even extremely cold climates and left in the ground over winter, and (2) tender sorts that, except in the warm South, should be planted in spring, lifted in the fall and stored indoors through the winter.

Such a classification will not apply, of course, in parts of the country where winters are mild. Many bulbs which come through the winter successfully and might be classed as hardy in Washington, D. C., must be stored indoors farther north. Gladiolus will survive the dry winters in Florida but they really need a cool period to break their dormancy and promote uniform growth.

Most hardy bulbs are spring flowering, though some lilies and colchicums are not. They should, therefore, be planted in the fall at least four weeks before the ground freezes (colchicums even earlier) so that the roots can become well established. Tests have shown conclusively that winter damage is more severe in late plantings than in those which were well rooted before the earth froze.

In the North, tender bulbs are all summer flowering. It takes some time for them to establish roots and develop leaves and flowers after they are planted in the garden. Planting time for them will vary from early to late spring, according to the climate. Consequently, flowering dates vary greatly.

Tender bulbs are lifted in the fall as soon as frost has touched the foliage. They should be spread out to dry in any airy spot at room temperature. As soon as they are dried to the point where the old foliage and roots can be removed without damaging the bulb, they are cleaned, rogued of diseased bulbs and stored at a temperature of 40° F. under conditions where they will neither be excessively dried out nor constantly damp. Some need special treatment, as pointed out in articles on particular genera.

The lesser-known bulbs (see pages 65-95) usually demand special conditions of soil, moisture, light, etc. They are, therefore, not so easily grown as the others and this, to a degree, explains why some of them are less popular.

Some kinds of bulbs which can be successfully grown in southern gardens may also be forced indoors or in greenhouses. Not all require the same treatment during their resting or dormant period, and their needs as to temperature and light vary too. They fall into the following classes:

Half-Hardy Bulbs to Grow Indoors

These bulbs require a cool rooting period before forcing:

Albuca	Lycoris
Anemone	Moraea
Babiana	Ornithogalum
Brodiaea	Ranunculus
Freesia	Sparaxis
Gladiolus	Sprekelia
Lachenalia	Tritonia
Lapeirousia	Zephyranthes
Leucocoryne	

Tender Bulbs for Year-around Indoor Bloom

Pot in fibrous soil and leave the bulbs in the same pot until they become badly pot bound, thus requiring repotting to a larger size pot. Rest in a cellar or under the greenhouse bench with very little water during the summer months. Supply water and light when growth starts. Give liquid feeding every three weeks as soon as the flower buds show. All like sunshine.

Alstroemeria	Cyrtanthus
Amarcrinum	Eucharis
Amaryllis	Haemanthus
Clivia	Nerine
Crinum	

PLANT IN SPRING

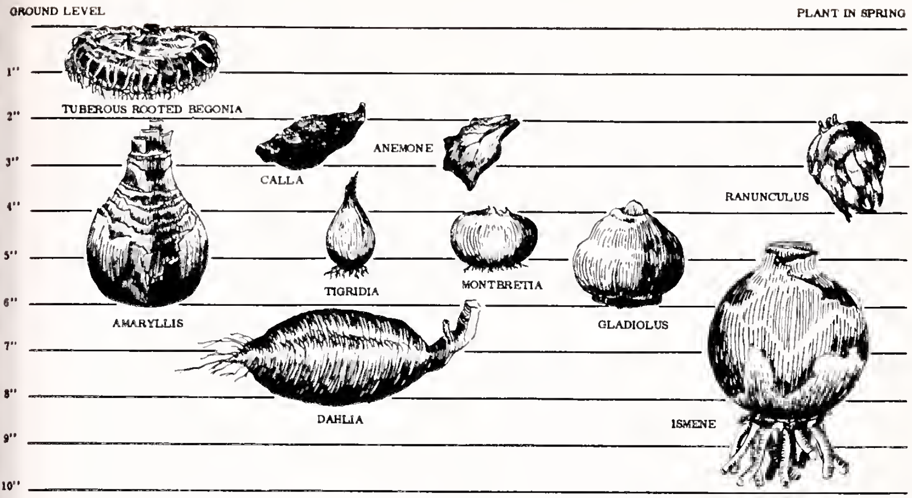
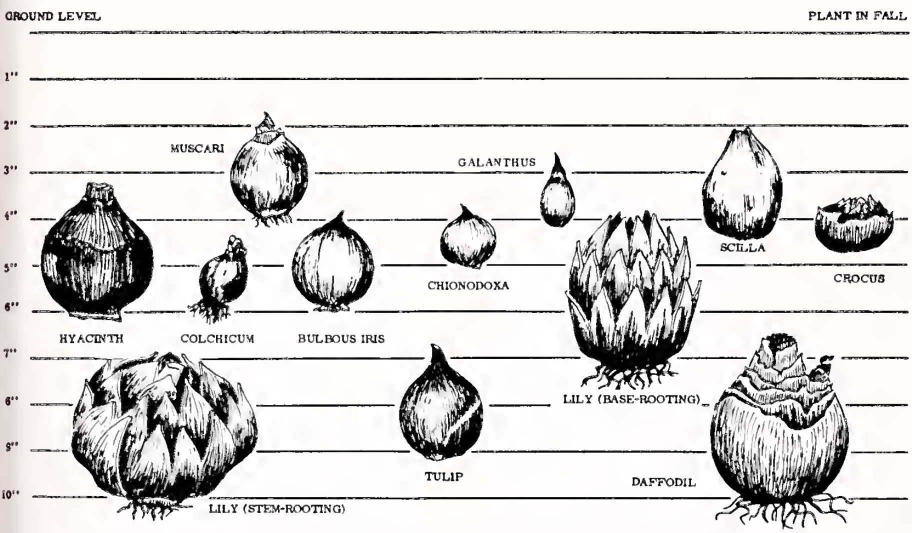


Diagram showing the depth to plant the more popular bulbous plants.

PLANT IN FALL



Time of year to plant, and depth of planting for temperate climates, where winters are cold. For frost-free climates, some kinds are planted at other seasons

Continued from page 8

The following prefer high humidity and part shade:

Arum
Caladium
Hydrosme
Zantedeschia (Calla)

Others of varying culture:

Eucomis
Gloriosa
Ornithogalum
Oxalis
Schizostylis
Tulbaghia
Veltheimia

GENERAL CULTURE OF BULBS

Certain precautions will insure success

MOST bulbs will grow satisfactorily in any average garden soil, from light sandy loam to fairly heavy clay. The one important soil condition they must have is good drainage. If this cannot be arranged, the growing site is not suitable and another should be used.

Like most plants, bulbs grow best in a fairly open fibrous loam. Hence, for good results, it is advisable to improve poor soils by adding leaf mold or garden compost.

Heavy clay can be lightened by adding sand and compost. Light sand can be prevented from drying out too quickly by the addition of compost or well-rotted manure at the rate of 5 to 6 bushels per 100 square feet of bed area. This is done by digging these materials thoroughly into the soil well in advance of plantin to improve soil texture. Digging manur into the soil in spring preceding fa planting of the bulbs is the best practic

Most bulbs succeed in a neutral o slightly alkaline soil. If the pH value i below 6.5, it is advisable to add groun limestone at the rate of 5 pounds per 10 square feet for each 0.5 difference in pH value required.

Drainage. Although bulbs grow bes when there is a ready supply of moistur at the root tips—in Holland the wate table is 10 inches below the surface—it i useless to try to grow them in low spot where water lies in winter or spring Where drainage is poor, it is necessar to install drainage tiles to carry the wate away. Even where fair drainage exists i

Autumn Planting of Bulbs

One way to visualize how a border of spring bulbs will look is to sketch a planting plan on paper. Then spread paper cut-outs (the actual size of the bulb clumps) on the ground; hold down with bags of bulbs

Before planting, dig peat moss or humu deeply into the entire bed. Then remove soi to 6-inch depth, where each bulb group i to be planted, and mix bone meal or othe bulb fertilizer into bottom soil layer

clay soil it is better to place a layer of sand in the bottom of the hole in which a bulb is planted.

Fertilizer. It is difficult to say which is the best fertilizer for most bulbous plants. Provided the soil contains a reasonable amount of the nutrient elements, most spring-flowering bulbs show little response to fertilizer the first year. This is understandable, since most dormant bulbs already contain next year's embryo plant which is well supplied with food materials stored in the bulb tissue. However, fertilizers high in phosphorus and potash are beneficial. They should be worked into the ground just before planting at the rate of 5 pounds of a 5-10-15 fertilizer per 100 square feet. This is followed by 1 pound of ammonium sulphate scattered over the same area early in the spring. Fertilizer helps particularly in building better bulbs for the following year.

Watering. Hardy bulbs are at their best in districts where spring is a long cool season, otherwise the jump from winter dormancy to bloom and maturing of foliage is so rapid that there is little time for the bulb to store the food necessary to produce bloom next year. This, coupled with the tendency of hot dry summers to induce production of extra dormant buds at the base of the bulb, results in the development of several small bulbs and offsets, rather than the production of large bulbs. This explains why the commercial production of tulips, daffodils and others is practiced only in a few small areas in the world where soil and climate are ideal.

The addition of water just before and immediately after bloom, tends to prolong the season of growth as does also scattered shade in mid-afternoon, such as that cast by tall trees.

Light. Provided there is ample moisture, most bulbs prefer sunlight all season. The hardy spring-flowering bulbs grow very well under deciduous trees particularly if the branches are high overhead. Many native bulbous plants such

Replace enough soil over the bottom soil layer to prevent bulbs from touching fertilizer. Space the bulbs as shown, then cover with top soil and press down firmly. Label each group, or make small planting plan

Digging Tender Bulbs in Autumn

Before heavy frost in fall, dig such tender bulbs as Ismene, place them without soil in open flats to dry, and in a warm, airy place. Remove tops when dry. Store bulbs for the winter at 50°F. or higher

Roche

When healthy new bulbs are planted in a new location, there is little chance of disease the first year. But if new bulbs, such as tulips, are planted where other tulips grew last spring, they may contract Botrytis blight or tulip "fire." Any bulbs showing unusual leaf symptoms such as color mottling, stunting, variegation, or rotting of the bulbs, should be carefully "rogued out," and no other bulbs replanted in the same location for at least a year. Dr. Cynthia Westcott prepared the chart on the opposite page, which appears here by courtesy of Dr. Westcott and "The National Gardener," published by the National Council of State Garden Clubs.

as daffodils, scillas, and snowdrops, are well adapted to such conditions.

Most tender bulbs are descended from species which come from hot semi-tropical climates where heat is coupled with humidity. Some prefer full sun, a few like shade.

Pests and diseases. Bulbous plants, like others, are attacked by insects as well as fungus and virus diseases. Protective measures need to be taken. It has become almost impossible to grow gladiolus without spraying the plants with D.D.T. or lindane to control thrips; to grow tuberous begonias without applying a fungicidal treatment such as karathane to control mildew; or to transplant lilies without treating the bulbs with a ceresan dip to combat basal rot.

Mention will be made elsewhere of specific diseases of particular bulbs but general precautions are as follows:

1) Practice clean cultivation. Weeds and rubbish make good hiding places for insects and fungus spores.

2) Disinfect storage cellars, flats, etc. with a fungicide, such as ceresan or zineb, that is non-injurious to plants.

3) Dust all stored bulbs with 3 per cent D.D.T. in combination with a fungicide. Such dusts are available through leading seed stores and garden centers.

4) Spray growing plants regularly with one of the new combination sprays to protect them against both diseases and insects.

5) Dig up and burn all plants which show virus infection. This also applies to bulbs and corms that show inroads of fungus disease such as botrytis in tulips or scab in gladiolus.

Harvesting and storage. Bulbs that are to be moved and stored should be lifted as soon as the foliage dies. With the hardy spring-flowering bulbs this will be approximately a month after bloom is over, though this varies with location. In the case of tender summer-flowering bulbs such as gladiolus and tigridias, they should be lifted before the ground freezes or as soons as the tops wilt.

With the exception of loosely constructed bulbs, such as lilies, they should be dried out thoroughly in order to avoid fungus rots. If tops are green when the bulbs are dug, they should be cut off an inch or two above the bulb. After bulbs are thoroughly dry they may be cleaned of dead tops, roots and old loose scaley tunics. Cleaning earlier than this often damages the base plate.

All bulbs showing signs of disease or injury should be discarded to prevent spread to the healthy ones. Hardy bulbs of flowering size can be replanted in fall where they are to bloom. Smaller ones can be lined out in a row in the kitchen garden if you are thrifty. Some of them may increase in size to be of use later. After drying, most of the tender bulbs should be dusted with a fungicide and mixed with very slightly dampened sphagnum moss or vermiculite to prevent excessive drying. Gladiolus and some others do not need this treatment and can be left in open paper bags or trays. Most of the tender bulbs should be stored at a temperature of 40° - 50° F. in very dim light.

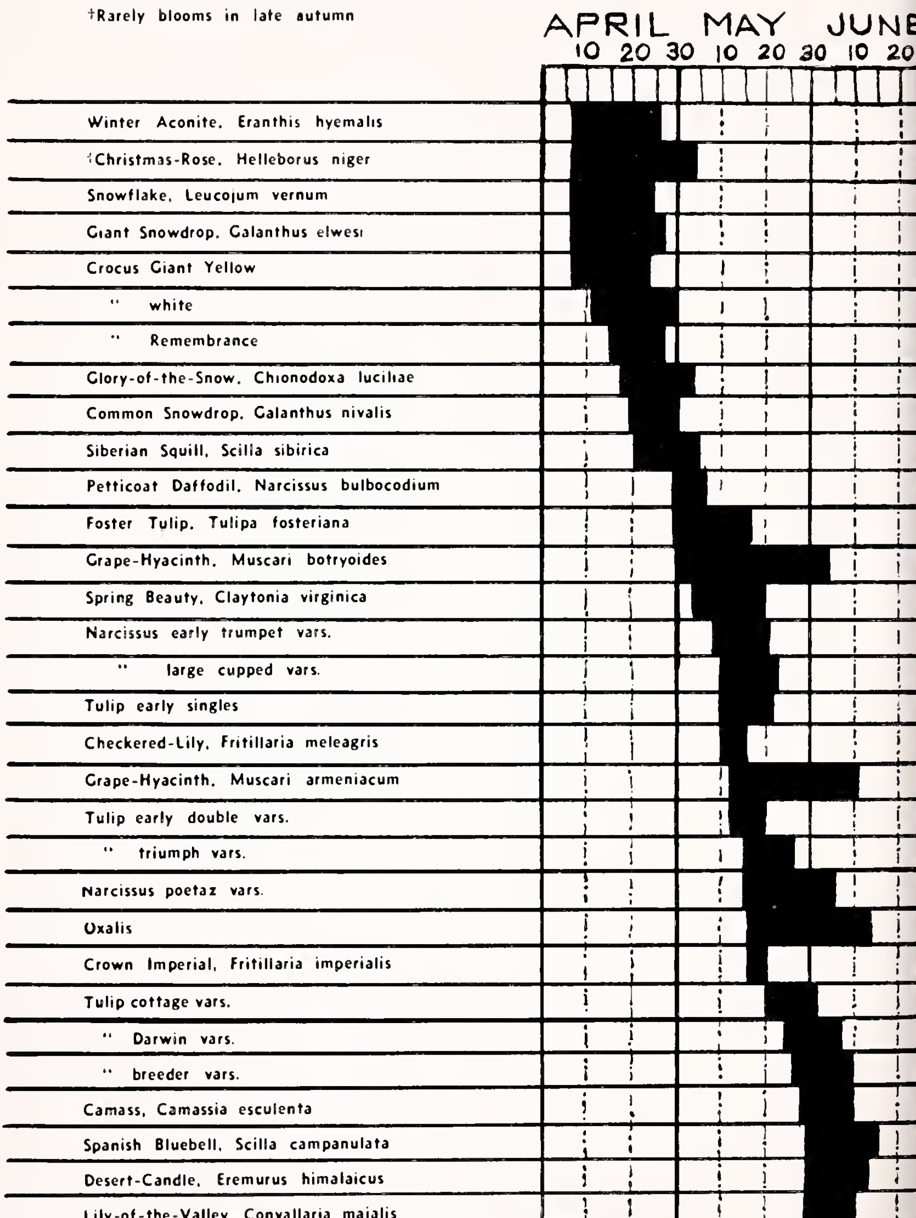
COMMON BULB PESTS AND DISEASES AND THEIR CONTROL

HOST, Pest, Disease	DAMAGE	CONTROL
AMARYLLIS		
Convict Caterpillar (In southern gardens)	Dark larvae with cream-colored bands, 2 inches long, devour leaves.	Dust with DDT.
Bulb Mites	Rotting bulbs. See Hyacinth.	Discard soft bulbs.
Narcissus Bulb Fly	Decaying bulbs. See Narcissus.	Discard soft bulbs.
Leaf Scorch, Red Blotch	Reddish spots on flowers, leaves, bulb scales; stalks deformed.	Discard bulbs or remove diseased leaves. Avoid heavy watering.
GLADIOLUS		
Thrips	Leaves silvered, flowers streaked, deformed.	Spray or dust with DDT. Dust corms with 5% DDT after harvest.
Botrytis and other flower blights	Flowers, leaves, stalks spotted, then blighted.	Spray with zineb (Dithane Z 78 or Parzate).
Corm Rots, Scab	Lesions on corms, spots on leaves.	Dust with Arasan before planting.
Yellows (due to a soil fungus	Plants infected through roots, turn yellow and wilt.	Choose resistant varieties.
HYACINTH		
Bulb Mites	Minute, less than 1/25 inch, white mites in rotting bulbs.	Discard infested bulbs.
Aphids, several species	Leaves are curled; virus diseases may be transmitted.	Spray with malathion, rotenone, or nicotine.
Bulb Nematode	Dark rings in bulbs.	Discard.
Soft Rot	Vile-smelling bacterial disease, often after mites.	Discard.
IRIS (Bulbous)		
Tulip Bulb Aphid	See Tulip.	See Tulip.
Gladiolus, Iris Thrips	Leaves russeted or flecked, flowers speckled or distorted.	Spray or dust with DDT, malathion, or lindane.
Leaf Spot	Light brown foliage spots with reddish borders.	Spray with zineb or bordeaux mixture; clean up old leaves.
LILY		
Aphids (Lily, Bean, Melon, Peach, other species)	Curl leaves, transmit mosaic and other virus diseases.	Spray with malathion, being sure to cover underside of leaves.
Botrytis Blight	Oval tan spots on leaves, which turn black, droop.	Spray with bordeaux mixture.
Mosaic and other virus diseases	Plants mottled, stunted.	Rogue infected plants. Start lilies from seed in isolated portion of garden.
NARCISSUS		
Narcissus Bulb Fly	Fly resembling bumblebee lays eggs on leaves near ground in early summer. Larva, fat, yellow maggot ½ to ¾ inch long, tunnels in rotting bulb.	Sprinkle naphthalene flakes around plants to prevent egg-laying. Before planting dust trench with 5% chlordane and dust over bulbs after setting.
Bulb Nematode	Dark rings in bulb.	Discard bulbs. Commercial growers treat with hot water, adding formalin to prevent rot.
Basal Rot	Chocolate-colored dry rot at base of bulbs.	Inspect bulbs before planting.
Smoulder (Botrytis Rot)	Plants stunted or missing; masses of black sclerotia on rotting leaves or bulbs.	Remove diseased plants. Put new bulbs in new location.
Scorch	Yellow, red, or brown spots blight tips of leaves.	Spray or dust with zineb, maneb or copper.
TULIP		
Tulip Bulb Aphid	Powdery white or grayish aphids common on stored bulbs.	Dust with 1% lindane before storing.
Green Peach, Tulip Leaf and other Aphids	Transmit viruses to growing plants.	Spray or dust with malathion or lindane.
Botrytis Blight, Fire	Plants stunted, buds blasted, white patches on leaves, dark spots on white petals, white spots on colored petals, gray mold, general blighting. Small, shiny black sclerotia formed on petals, foliage rotting into soil and on bulbs.	Discard all infected bulbs. Plant new tulips in new location. Spray with ferbam or zineb, starting early spring. Remove flowers as they fade, remove all tops as they turn yellow.
Cucumber Mosaic	Yellow streaking or flecking of foliage.	Do not grow near cucurbits or gladiolus.
Lily Mottle Viruses	Cause broken flower colors, mottled foliage, in tulips.	Do not plant near lilies. Control aphids.

CALENDAR OF BLO

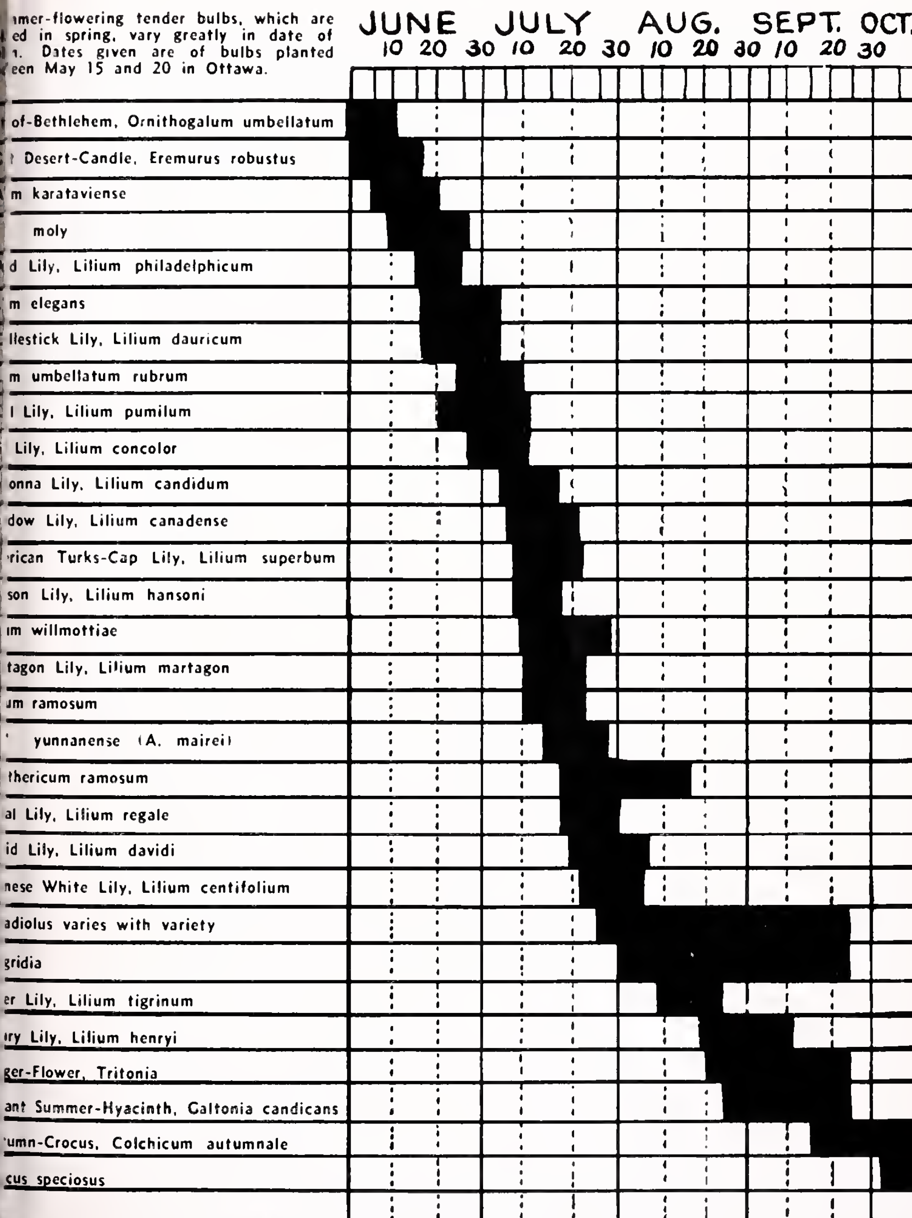
Blooming dates are based on a five-year average at Ottawa, Ont., Canad

Dates at which different kinds of bulbs bloom will, of course, vary accord to the latitude and climate where they are grown. Spring comes early in South and spreads over a long season. In the North, the transition from wir



R HARDY BULBS

summer is much more rapid. Thus, there is a difference in dates when any en bulb will bloom in Philadelphia as compared with Ottawa, Ont., and yet order in which different bulbs bloom is about the same, North or South.



BULBS FOR MASS EFFECT

In parks or park-like settings

Edward I. Wood

OF all the fields of landscape design, the one which has lagged furthest behind is that of floral design in parks.

Flower beds in the shape of crowns and crescents, stars and circles came to us with the importation of English, Scottish, and German gardeners who had been trained on the estates of the earls, dukes and barons of their own lands.

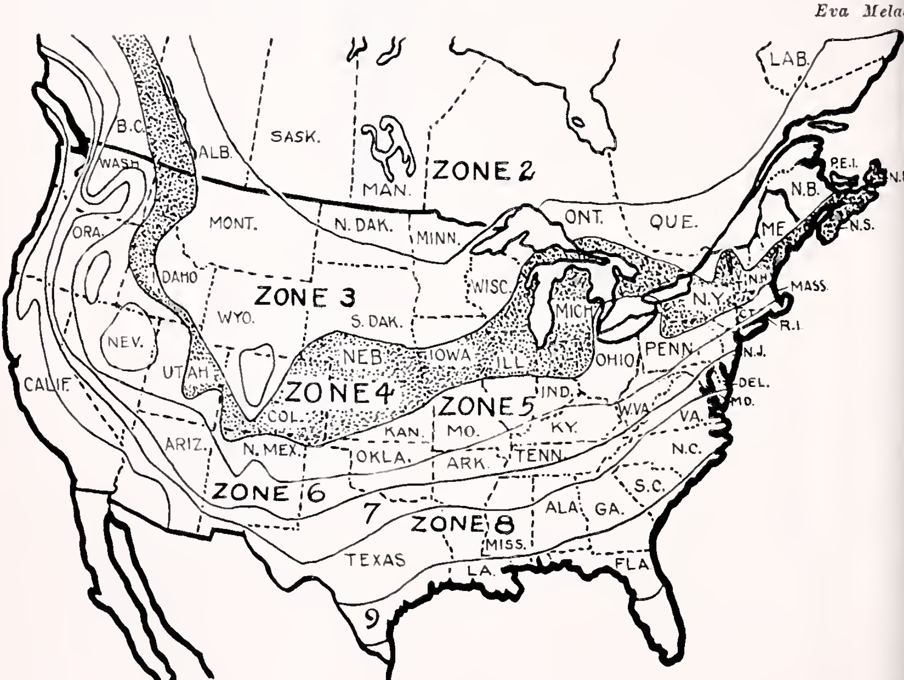
When they first came to North America, they may have been justified in using plants that way, because our homes were cluttered with Victorian furniture, our walls were hung with numerous elaborately framed pictures or laboriously worked mottoes or floral needlework. Long working hours and long working weeks with low incomes kept the family at home. Sunday, they dressed in their best an strolled leisurely through the park to ga in awe and wonder at the intricacies o the carpet bedding. It all fitted togethe Labor was cheap; travel was slow. Fol age and tropical curiosities belonged t the fashions of the times.

These conditions no longer exist. Fe people walk; most travel by car, and a considerable rates of speed. The old styl flower bed can no longer claim a place i public park plantings.

On the driveways of Ottawa we us mass plantings of bulbs followed by an nuals. These are located on banks a curves in the roadway so they can b observed from a distance. Up to 120,00 plants have been used in a single bed wit

Climatic Zone Map. Flowering dates of bulbs vary, depending upon the range of tem perature in any given area. Ottawa is in Zone 4, as indicated on the map. Bulbs bloom progressively earlier in zones southward of Zone 4, and later in Zones 3 and 2

Eva Melad



In Ottawa's parks, tulips are massed on banks where they are most easily seen. Large numbers of each variety are grouped for harmony of color, one with another, so as to present a pleasing over-all effect

Author photos

one block of a single variety having 7500 blooms.

The peak of effectiveness comes with the spring-flowering bulb show through May.

When the long winter months have passed and succeeding thaws have dropped layer after layer of dust, grime, and soot on the dirty snow below, all is gloom and spring seems far away.

Suddenly the crocus is here! Blues, yellows, purples and whites, overnight, have poked their brilliance through the grass in sweeping drifts. The impact is so great that you can see glum frowns change to smiles as bus riders, bound for work,

Naturalized crocus are planted in the center of the city where thousands of people may admire them. (Lawns where crocus, daffodils, etc. are planted, cannot be mowed until the foliage dies back. This means an unkempt lawn for many weeks)

pass the large masses on downtown grassy slopes. There were a million and a half of these blooms in Ottawa in the spring of 1959 and every year the number increases.

Next come minor patches of grape-hyacinths (*Muscari*) and scillas together with brilliant patches of 'Red Emperor' tulips. The sequence continues with single early and double tulips. Daffodils overlap both the early and the late tulips which complete the show.

The average annual expenditure for bulbs has been about six thousand dollars. For this small amount the flowering bulb season has been greatly extended. Newspapers, house organs, radio and TV have given untold space and time. National magazines have carried feature articles.

To achieve this, several points have been observed:

1. The general principles of design have been brought into play and the sites of all displays have been determined with fast-moving motor traffic in mind.

2. The main cultural principles (detailed elsewhere in this handbook) are followed. This allows us to carry the most important beds for two or three years without change. It also yields a considerable per cent of bulbs large enough to replant.

3. Top sized bulbs are not used. Tulips 11-12 cm., crocus 7-8 cm., daffodils double nose and rounds are the sizes specified.

4. Bulbs are bought by specification and tender.

5. Only the reliable, less expensive varieties are used.

6. Tulips are planted a minimum of 6 inches deep.

7. General spacing for tulips is 6 inches. In large beds this can be increased to 8 inches. Bulbs in outside rows and rows next to other varieties are spaced at 5 inches. Where free-standing beds are raised in the center, the top of the heap is more thickly planted.

8. Parrot tulips and other weak-stemmed types are not used.

9. The great majority of varieties used have blooms of only one color. More than

Placing this bed of tulips on a bank at a curve makes it visible for a long way when approached from either direction. The use of light colors in a shady location next to trees brightens the display

Daffodils look well when naturalized in sizeable areas of open grass in front of strong backgrounds. This area yields up to 40,000 bulbs a year to plant in new places as thinning is done to prevent overcrowding

Tulip Plantings at Kingwood Center, Mansfield, Ohio

As a variation of the conventional formal beds in which tulips often are planted, bulbs are grown in free-form beds in open lawn areas between trees. Several kinds are planted in one bed, but each is in a solid, irregularly-shaped mass. Colors either blend closely or are in strong contrast

The beds are deeply prepared first, and bulbs placed at proper planting depth (and labelled) before being covered with top soil, as pictured below

one color in a bloom usually destroys the strength of a mass from a distance. Crinkly edges and feathering of petals do the same thing. Double tulips, except earlies which are viewed from above, are not used.

10. An attempt at pattern within a bed is seldom used. All smaller beds are of one variety except a few which may have a contrasting border.

In floral design, dominance is a most important factor. One color or, in the very largest displays, two colors should stand out both in mass and intensity from the rest of the components. All other colors should be in smaller groups and should be so chosen and arranged that they build up to and contribute to the most important flowers in the display. There are some flowers in dull, mute or off shades which have little beauty in themselves but which, when mixed with the others, by their very drabness can enhance the beauty of their more attractive sisters. They should be used only sparingly.

Once in a while very dark colors may be used to form splashes of contrast in the middle of lighter fields. Small dark

patches should never be used on the outside of borders. They give the impression of a grin with a tooth out.

Color is a very complicated subject which must be left for your own study. Catalog descriptions are never accurate enough to be a sure guide in combining varieties. Success depends largely on trial and error but the satisfaction in success is immense.

FORCING BULBS INDOORS FOR FLOWER SHOWS

Helpful schedules for time and temperatures

W. B. Wallen

WHEN I first considered growing bulbs indoors for competition I did as most of us should do, studied articles written by others with experience and asked growers and former exhibitors for opinions and records.

I soon discovered that there are two general rules which must be followed if one is to get the best results:

1. Bulbs are ready to grow when they are purchased in the fall. Most of the work of producing a bulb which will surely bloom has been done by the grower. However, bulbs vary greatly in size and quality, so it pays to get only the highest quality and healthiest bulbs possible.
2. To encourage bulbs to produce the best flowers from their embryo blossoms already present, it is necessary to provide the best environmenta conditions. Good root growth mus be developed before the bulbs ca do their best.

It was evident from the start that tim of planting, temperature of the dark roon in which the bulbs were to develop roots and proper ventilation to assist in pre vention of disease were all important fac tors in forcing bulbs into bloom indoors

However, even when one has the calr assurance of general knowledge gaine from reading, the fearsome and challeng ing part in forcing bulbs for exhibitio is that a definite amount of time must b allowed for each stage of growth—root ing, stretching the flower stalks, an bringing the plants to maturity in orde to hit the deadline of a flower show.

Competitors often guard their secrets

How to Pot Tulips

Cover drainage hole in bottom of thoroughly clean pot with piece of broken clay pot

Next, cover bottom with layer of sphagnu moss or screenings before putting in soil

McFarlan

One of my friends responded to questioning with the very general information that it took the following periods for bulbs to be brought into bloom after removal from cool storage, but that it varied with varieties:

Daffodils, an average of 19 days
Hyacinths, an average of 14 days
Tulips (early double), 16 to 19 days
Tulips (early singles), 19 days
Tulips (Darwins), 35 days
Tulips (Breeders), 40 days

These periods seemed to me to be too short, but with this and other bits of information, a start was made to force several hundred bulbs of recommended varieties of crocus, hyacinth, daffodil and tulip (see page 24).

Daffodils and tulips were potted on October 13, crocus and hyacinths on November 1. Pots were placed in the bottom of a trench 12 to 15 inches deep in the garden, watered thoroughly, and covered with cinders, which seemed to be a time-honored practice. The ground froze hard around them early in November.

The basement of our home seemed to meet the necessary requirements as a storage place for the bulbs when they are brought in from outdoors. There is a dark, cold room where the temperature in winter holds very close to 48° F.—an ideal temperature for rooting. Another large room varies in temperature from 48 to 55° F. with partial light suitable for "stretching" the flower stalks, before taking them to upstairs rooms for higher temperature and sunlight.

Finally, when the bulbs were ready to force into bloom, the pots were placed as close to the windows as possible and turned occasionally. We found that locations with temperatures varying from 50 to 55° F. were favorable for crocus; 55 to 60° F. suited daffodils; and 60 to 68° F. best for tulips and hyacinths. Most homes are kept much too hot for good results in bulb forcing.

The first year all pots of bulbs were brought from the garden to the cold cellar on December 12 and left there for several weeks to establish good root systems. They were watered sparingly at first, gradually increasing the amount as roots developed.

In order to establish preparation time for a flower show, it is necessary to keep careful records for each variety from year to year. The following summary of notes may be helpful:

Add enough soil so that tips of bulbs will be a half inch below the rim of the pot

Firm soil around the bulbs. Soak thoroughly by standing the pot in a pan of water

Roche

Pre-rooting bulbs for forcing. Plunge potted bulbs to rim in coldframe. Spread sand over pots if soil is used as covering

By covering with inverted pots before addin protective layer of soil, checking growt progress is easy; mice are repelled too

Crocus var. 'Remembrance'

Potted November 1; cold storage December 12 - January 28.

Then taken to cold outer basement. Leaves $2\frac{1}{2}$ inches with small green tips.

February 4: leaves green; inner white sheath showing around flower buds. Taken upstairs to sunlight and temperature of 50° F.

February 10: entire pot of 12 bulbs open and at their best.

Observation: crocus takes from 12 to 13 days to develop after leaves are 2 to $2\frac{1}{2}$ inches tall.

The next year I needed them earlier, so took pots of *C. tomasinianus* out of storage December 25. Although the finished product was beautiful, it took twenty days from storage to maturity of flowers. My observation was that crocuses should be kept cold during a rooting period of six weeks.

Daffodils

Several varieties were grown. Here are the notes on 'Golden Spur.'

Potted October 13; cold storage December 12 to 25. Shoots 2 inches high when moved to sunlight at temperature of 55 to 60° F.

Observations were that the bulbs mad little growth the first two weeks and too six weeks to bloom—they were not lon enough in cold storage to develop a roo system and "stretch" the flower stalks.

The next year more varieties wer grown for exhibiting on March 11. started to get jittery about the first o February and brought out 26 pots o February 5, placing them in sunlight a 55 to 60° F. All had shoots $1\frac{1}{2}$ to inches high then.

Most of them made the show in goo condition. Observations were that Feb ruary 5 was too early for 'Golden Har vest' and 'Twink,' which would have bee in better condition if they had bee brought out February 10 to 11.

February 5 was just right for 'Verge and 'Daisy Schäffer' but 'Geranium should be brought out a week earlier.

Tulips

Tulips are harder to grow because the often need "stretching" and there is greater difference between timing of va rieties.

Mulch frame deeply with salt hay or similar material, letting labels show. In coldest areas, more cover may be needed

Roche

Lacking a frame, plunge pots in deep trench having gravel bottom. Cover with inverted pots, mound of soil, hay mulch

Here are the notes for a year when the flower show was March 11. Potted October 13; kept in cold storage room December 12 to January 28.

January 28, brought 35 pots from cold storage to outer basement room. Shoots were as follows:

General de Wet	1½ in.
Peach Blossom	1½ in.
Advance	1 in.
Carrara	3 in.
Her Grace	3 in.
Chas. Needham	2 in.
Insurpassable	2 in.
Mrs. J. T. Scheepers	4 in.
Wm. Copeland	3 in.
Louis XIV	1½ in.

When bulbs are brought inside, their tops should be well above ground. By keeping them in a cool dark cellar, the tops draw up ("stretch") and flower buds are exposed—see hyacinths in foreground

Malak

Recommended Varieties of Spring Flowering Bulbs for Indoor Forcing

Crocus: Giant Yellow, *purpureus grandiflorus,* Kathleen Parlow (white), Remembrance (lavender-blue), *sieberi* (force slowly).

Daffodils: Division I—Trumpet: Aerolite, Beersheba, Golden Harvest, Mrs. R. O Backhouse, Magnificence, Mount Hood, Oliver Cromwell, Pink Glory, Peerless Gold, President Lebrun, Pink Select, Queen of Bicolors.

Division II—Large Cupped: Carlton, Dairy Schäffer, Dick Wellband, Deanna Durbin, Duke of Windsor, Flower Record, Fortune, Helios, Makassar, Scarlet Elegance.

Division III—Small Cupped: Firetail, Snow Princess, Tunis.

Division IV—Double: Texas, Twink, Van Sion.

Division VI—Cyclamineus: Peeping Tom.

Division VIII—Tazetta: Early Perfection, Geranium, Laurens Koster, Cheerfulness (double).

Division IX—Poeticus: Actaea, Sarchedon.

Hyacinths: White—Edelweiss, L'Innocence; Pink—Ann Mary, Mr. Dames, Pink Pearl; Light Blue—Delft Blue, Dr. Lieber, Myosotis; Dark Blue—Bismarck Grand Maitre, Ostara.

Tulips: Early Single: Bellona, Brilliant Star, Diana, Flamingo, General de Wet Keizerskroon, Prince Carnival, Sunburst, Vermilion, Brilliant, White Hawk

Early Double: Dante, Electra, Mr. van der Hoef, Mme. Testout, Orange Nassau Peach Blossom, Schoonoord, Titian, Tea Rose, Wilhelm Kordes.

Mendel: Her Grace, John Gay, Krelage's Triumph, Olga, Orange Wonder, White Sail.

Triumph: Attila, Blizzard, Bruno Walter, Crater, Edith Eddy, Elizabeth Evers Kansas, Telescopium, Zimmerman.

For Late Forcing Only

Cottage: Albino, Carrara, Golden Harvest.

Darwin: All Bright, King George V, Copelands Rival, Insurpassable, Margaux Mrs. Grullemans, Paul Richter, Prunus, Princess Elizabeth, Red Pitt, The Bishop.

Breeder: Admiral Tromp, Louis XIV, Panorama.

Continued

February 7: Moved all to upstairs room at temperature 60 to 62° F.

February 14: Growing too fast; plants returned to 48° basement. Those with flower buds placed in temperature of 40° F., with dim light. Paper collars placed on pots that had too short stems.

February 28: Very little growth was made at 40° F. Took all pots upstairs again at 60° F.

March 9: Some were beginning to open.

March 11: Most of them reached the show in good condition. 'Mrs. J. T. Scheepers' failed because of being held back so long.

Counting on the above performance, the next year all pots were left in cold storage another week, Breeder varieties being an exception. This almost caused my undoing due to several very dull days. However, recovery in growth was made by hanging enough 100-watt electric lights above the bulbs in a white-walled room so that the tops of the plants received light intensity of 90 to 100 foot candles. These were kept on until 9 o'clock each evening.

The tulips were in good condition by the time of the show.

Potted bulbs are colorful decoration for a modern interior. There is evidence here of skillful forcing

In order to get different kinds of bulbous plants to bloom at the same time, they must be brought indoors at different times

Hyacinths

Hyacinths may be planted later than other bulbs but require care in getting the bud up out of the bulb. For the flower show on March 11, the record was as follows:

Varieties 'Jan Bos,' 'Bismark,' 'Lady Derby,' 'Grand Maetre,' 'Myosotis,' 'L'Innocence.' Potted November 1, cold storage in the cellar December 12 to February 15.

February 15: Moved all pots to outer basement room. Placed paper cones 12 inches tall with 4-inch opening at top over large (6- or 7-inch) pots. Inverted pots of same size over the smaller pots. This was to accelerate elongation of the flower stalks. At this time the shoots were about 1½ inches high. Temperature 68 to 70° F.

February 20: Removed cones and brought all that had the flower spike showing well out of bulb, up to the light. Leaves were about 4 inches. The rest were left a few days longer to "stretch."

March 4: Spikes appeared too bunched so they were all moved to cooler room about 60° F. in sunlight.

March 11: All out and ready.

All things considered, to prepare a number of kinds and varieties of bulbs to bloom on the same day is an interesting experience.

Malak

Bulbs are not ready to force until roots have developed after ample cold period, as shown. This stage has been reached when roots poke through bottom drainage hole

TENDER BULBS FOR THE HOUSE

Good ones to select, and how to treat them

Sylvia Hathaway Evans

TENDER bulbs bring winter bloom into the house, along with a certain amount of trouble; but with individual attention and patient care, they well reward those who like to grow their own at any cost.

Tender bulbs, as distinct from hardy bulbs, are those that must not be frozen. Such bulbs should be planted in rich soil, and brought to maturity slowly. They should be started in partial shade with a moderate amount of water, and grown cool from beginning to end. A temperature of 60°F. is much more congenial to them than the humanly preferred 70°. With patient growing (not forcing too fast), and with periodic repotting in new soil, most of these bulbs may be used year after year. There are various groups of tender bulbs, suitable and wholly satisfactory for ordinary home use, which respond to slightly different methods of treatment.

Easier Group

Probably the easiest winter house bulbs, and the most completely foolproof are those of the paper-white narcissus (pure white form of *Narcissus tazetta*), and the yellow variety, 'Grand Soleil d'Or,' and the Chinese sacred-lily (*Narcissus tazetta* var. *orientalis*). These may be grown in fiber or in pebbles, with about three-quarters of the bulb above the surface. They should be planted about the middle of October or later. Until a strong root system develops and top growth starts (usually two or three weeks), the pans or bowls of bulbs should be kept in a cool, dark place. Successive plantings about two weeks apart can keep these flowers in bloom in the house from Thanksgiving until March. Bulbs planted after December 1 will make sturdier quicker growth, and will be more satisfactory than those planted early. These bulbs will not force a second time.

Two other kinds, dependable and easy of culture, are the Cape-cowslip (*Lachenalia*) and *Veltheimia*—both from South Africa. Cape-cowslip bulbs may be potted in soil (equal parts of sand, leaf mold, and good garden soil, with a tablespoon of bone meal for a 4-inch pot) in September or October, and kept in cool and shady surroundings until November. (A shaded cold frame or protected outdoor situation is very good if an alert weather eye is kept for freezing conditions.) The bulbs may then be brought into full sunlight, and will usually be in bloom by Christmas. If the plants are kept cool and well watered, the flowers will last for several weeks. The bulbs of cape-cowslip are small, and may be planted three or five in 4- or 6-inch pots respectively, with the tips of the bulbs just covered. If watering is slowly decreased after flowering, and the leaves are allowed to dry gradually, the bulbs may be stored and used again. Our most satisfactory results have been with *Lachenalia pendula* var. *superba*, whose bright, curiously shaped flowers remind one of green-tipped fire-crackers. *Lachenalia tricolor* var. *aurea* is also good, but less interesting and less gay in color.

Veltheimia viridifolia has a large bulb, which should be planted alone in a 6-inch pot, the bulb half-covered by soil. Planted in September, and grown like the cape-cowslip, it produces a rosette of vigorous, broad, shiny, very bright green, strap-like leaves; it is a lovely and dec-

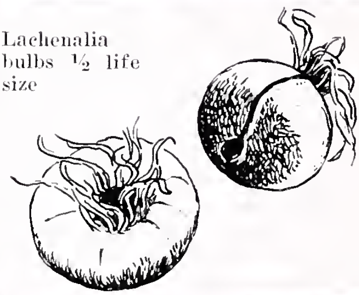
Cape-cowslip (*Lachenalia*) forces best at low temperatures. Flowers are gayly colored in gold and red. Lachenalia bulbs are below

Genereux

orative foliage plant during the winter, though it does not send up its single flower stalk until January. This stalk rises high and bears a long cluster of small rose-pink flowers, tinted variously with yellow, salmon, red, and green. It is a really rewarding plant, and well worth trying. These bulbs may be ripened off (after the flower stalk is faded and cut) like those of the cape-cowslip, stored in their pots during the summer, and repotted in the fall.

Another tender bulb, easy to handle and popular for winter bloom in the house, is *Hippeastrum*, commonly known as "amaryllis," and closely related to the true amaryllis, or belladonna-lily. The bulb produces strikingly gorgeous lily-like flowers of varied and vivid colors, from white to blood red, intense crimson and orange, and all sorts of striking combinations of bright colors. The bulbs may be potted any time after October, singly, in pots very little larger in diameter than the bulbs themselves. They bloom better if they are somewhat pot-bound; and smaller flowers are usually the result of letting the bulbs spend their energy in filling unnecessarily large pots with roots. They are greedy feeders; and so the soil should have a little more well-rotted cow manure or bone meal than is necessary for most of the other bulbs. The pots should be kept in a cool, dark place and sparingly watered for a period of six weeks to two months, so that roots may develop. Then the flower stalk (or stalks) will appear; and the plant may be brought first into the light, then into the bright sun; but it must not be subjected to high temperatures. After flowering is over, and danger of frost past, the plant may be put out of doors. It should have extra

Lachenalia bulbs ½ life size



Flowers of *Veltheimia viridifolia* are yellow, tinged red; the glossy foliage is just as ornamental as the flowers

Roche

feeding until late August, then moderat watering until time for frost. When col weather comes, it should be brought i (in the same pot until it really break out of it) and kept in a cool dark plac until fresh growth again gives the signa that a new blooming period is ahead.

Other interesting and more unusua bulbs, which may be treated like "amaryl lis" are the Jacobean-lily (*Sprekelia*) the Scarborough-lily (*Vallota*), both o South African origin, and the zephyr-lily (*Zephyranthes*), from the warmer region of America.

More Difficult Group

Freesias, and other bulbs requiring th same treatment, are an interesting but a rather more exacting group. Freesias should be planted in August or Septem- ber, because five months are required from potting time to bloom. The larges bulbs will give the most satisfactory re- sults; and if a succession of bloom is de-

Bulb Potting Methods

Before potting an amaryllis hybrid bulb snip off the dead roots and remove dry loose outer tissue (see above). Use a pot that is an inch or two broader than bulb. Set bulb so top half is entirely above ground

Paper-white narcissus is easily forced in pebbles and water. Keep the water level below the base of bulbs at all times

Freesias are not as easy to force indoors as are some other bulbs; they take a long time to bloom and must be kept very cool. Netted husk covers the corm (above), shown life size. It is a paradox that some people cannot detect fragrance in freesia blooms

sired, some should be potted every two weeks from mid-August until the end of September. About ten bulbs may be put in a 5-inch pot, planted an inch deep, in a well-drained soil prepared as for cape-cowslips. They may be kept outdoors or in a partially shaded frame until there is danger of frost, then brought into a cool house or greenhouse. They should be watered sparingly until the growth is really vigorous, and they will need less water if they can be kept cool. When active growth begins, they need more water, and in addition, a weekly feeding of liquid manure or some commercial fertilizer. The stems of freesias are weak, and will need careful staking and repeated tying.

The slower-growing bulbs of this group are much more subject to aphis than those mentioned earlier; and as the sun begins to grow stronger, in late January and February, their foliage should be carefully watched. Even before trouble appears, an occasional spraying with nicotine is a good preventive measure. The bulbs may be kept and used a second year —after replanting in new, rich soil. The bulbs in this group require more patience, more careful watching, and more babying; but with proper care they are very satisfying. Freesias are lovely in their soft colorings: pure waxy-white, saffron-yellow, and other delicate pastel tints; and their fragrance repays a lot of work.

Other bulbs that may be treated like freesias are the wand-flower (*Sparaxis*), mostly orange, yellow, and purple; globe-tulip (*Calochortus*), solitary and pale-colored; *Babiana*, bearing clusters of small showy flowers of blue and purple; *Ornithogalum arabicum*, like a glorified star-of-Bethlehem, with clusters of long-lasting, star-shaped white flowers, with dramatically black, shiny, bead-like centers; and "African corn-lily" (*Ixia*). Of these bulbs, next to freesias, we have had most success and satisfaction with ixias. They have stronger stems than freesias, and, in contrast with the gentle freesia colors, they come in strong vivid yellows, pinks, crimson, and scarlet. Without patient attention, the full success of these bulbs is doubtful; but all of them are worth a trial.

Genereu

This garden, awarded a gold medal by the Massachusetts Horticultural Society at a show in Boston, reveals Jean Thibodeau's skill in bulb forcing

HOW TO FORCE MINIATURE BULBS

Based on the long experience of Jean Thibodeau

Elizabeth Gordon Smith

EVERY March, thousands of people stand before the Alexander I. Heimlich ledge garden exhibits at the Boston and Washington, D. C., flower shows and feel spirited into spring as they look at drifts of miniature bulbs in full bloom. Jean Thibodeau, bulb expert at Heimlich's Woburn, Massachusetts, nursery, feels that many amateurs could have small "flower shows" at home in the late winter if they would force miniature and species bulbs. One may not, of course, get greenhouse perfection of bloom under home conditions, but very satisfactory results can almost be assured.

As a general procedure applicable to most miniature and species bulbs, the following methods are suggested for amateurs:

First, select top quality bulbs, robus[t] enough to grow strongly for good bloom ahead of their normal schedule.

Have the bulbs on hand to be plante[d] *at the latest* by November 10 or 11, as th[e] bulbs lose their vitality if held over an[y] longer. Planting can begin the middle o[f] October. Most potted bulbs should be kep[t] outside ten to twelve weeks before the[y] are taken indoors. This gives them [a] chance to develop really good root growth.

Plant bulbs in unpainted clay pots o[r] bulb "pans" (shallower than regula[r] pots) rather than in plastic containers, a[s] clay allows better drainage and does no[t] permit bulbs to remain too wet. Do no[t] use pans smaller than 3 inches in diameter, because very small containers allow moisture to evaporate too quickly.

Provide drainage in each pan by placing a piece of broken clay pot in the bottom.

Fill the pot to within one inch of the top with a general potting mixture of one-half good garden loam, one-quarter well-decayed compost, and one-quarter sharp sand (builder's sand). To each bushel of this mixture, add $1\frac{1}{2}$ quarts of Bovung, one-half quart bone meal, and one-half cup of superphosphate. Mix well.

Set the bulbs in the pots or pans so that their tips are covered with one inch of the potting mixture.

Then water the pots thoroughly.

Use at least a 4-inch label on which is written the date of potting, name of bulb, variety, and source.

Dig a trench out of doors in a spot sheltered from the wind which is at least 6 inches deep and wide enough to accommodate all the pots. Put one or 2 inches of coarse sand in the bottom of the trench for drainage. Fill in around the pots and cover on top with a 3-inch layer of cinders, if they are available, or sand. Water cinders as well as pots thoroughly.

When hard frosts come, but before the ground freezes to the depth of the pots—usually by early December in Massachusetts—cover with 2 feet of oak leaves or 15 to 18 inches of salt hay topped with evergreen boughs or branches to keep the cover in place.

When pans are put in a coldframe, rather than in the open ground, use the same procedure but close the window of the frame early in December, opening it on mild days so that too much heat will not build up inside the frame to stimulate top growth before the roots have formed.

About the first week in January, check the bulbs to see if they are ready to be taken inside. At this point, you must use some judgment, as different bulbs have different time schedules. The bulbs are ready for the next step in forcing if they have made luxuriant root growth and have started top growth.

When the bulbs are ready to go inside, move them to the coolest room in the house or under the bench in the coolest part of the greenhouse and keep them there for a few days—never more than a week—in the shade until they become accustomed to light. If they are put into the sun too quickly, the shoots may never turn green but stay a sickly yellow.

Still keeping the bulbs in the coolest room available, move them into the light, putting them as close to glass as possible so they will not grow tall and ungainly in their "search" for light. Few people can duplicate greenhouse conditions but for those who can, a daytime temperature of 60° F. and a nighttime temperature of 40 to 50° F. is ideal.

At this stage the amateur needs to do a little inspired guesswork that characterizes the work of the best professionals, especially to get bloom at a specific date. Understanding the basic principle that cold retards growth and warmth accelerates it, watch the plants and shift them to warmer quarters if they seem to be developing too slowly and to a cooler place if they seem to be too exuberant.

However, potted bulb plants at this stage need all the light they can get, provided, of course, they are given enough moisture through watering and syringing (wetting the foliage). Leggy plants with underdeveloped flower buds lurking under too much foliage either were not kept outside long enough to develop a strong root system, or once they were taken inside, were left in shade too long.

After the bulbs have been in a cool room for three or four weeks, shift them for a week or so to a room of intermediate temperature or to a warmer spot in the greenhouse before moving them to your living quarters. From the time the bulbs are taken out of the trench until they have finished flowering, they must never be allowed to dry out.

In February when the bulbs are fortifying your winter-weary spirits with their springtime bloom, take time to jot down notes on their performance, which will be helpful the following year in selecting new bulbs and caring for them through the forcing process.

Selecting Miniature Bulbs for Forcing

Of the hundreds of varieties of miniature and species bulbs available, these twelve (selected by Jean Thibodeau) are the easiest for home forcing.

Wind-flower (*Anemone*). *A. blanda atrocaerulea* in a dark violet blue and *A. blanda rosea* in a bright rose-pink are excellent varieties for forcing. Plant six to ten tubers in a 6-inch pan early in November. This is one bulb that is not started outdoors, but is kept in the dark in the coolest part of the house or under a bench in a cool greenhouse for about 6 weeks. A pinch of lime should be added to the potting mixture.

Glory-of-the-snow (*Chionodoxa*). All forms are good for forcing but *C. luciliae* 'Pink Giant' and *C. sardensis* in a strong blue are the most desirable. Since the bulbs are very small, five or six, depending on the variety, will fit into a 4-inch pan. Chionodoxa requires the general forcing conditions outlined earlier.

Winter Aconite (*Eranthis*). *E. tubergeni* and its variety 'Guinea Gold' are excellent for forcing. Start three or four in a 4-inch pan in the usual manner outdoors. However, they never should be covered over directly but topped instead with a larger size inverted pot which is then covered with cinders.

Guinea-hen-flower (*Fritillaria meleagris*). The variety 'Aphrodite' is the best of the whites for forcing and the variety 'Artemis' is a particularly good checkered wine-colored variety. A 6-inch pot will hold five or six bulbs comfortably.

Snowdrop (*Galanthus*). All varieties are good for forcing but *G. nivalis* in its double form is especially fine. During the rooting period, watch carefully by lifting up the leaf or hay cover, for signs of top growth. Once green shoots appear, bring it inside and keep in the coolest possible place since this bulb by nature thrives in the cold, flowering out of doors in the snow.

Iris reticulata. All varieties of this fragrant, early purple iris are good to force if they are given the same inverted-pot-on-top treatment as *Eranthis* and then covered with cinders or sand to the height of the covering pot. To provide necessary extra drainage, put an inch and a half of broken crockery in the bottom of the pot.

The beautiful golden yellow *Iris danfordiae*, which can also be forced, should be treated the same way.

Grape-hyacinth (*Muscari*). *M. armeniacum* 'Early Giant' is the most prolific and easiest to force into pre-season bloom. Plant three bulbs in a 3-inch pan in early November. If planted earlier, they will grow too quickly and their leaves will yellow.

Narcissus. With innumerable good forcing varieties to choose from, these three are the easiest—the primrose-yellow, early-flowering *N. cyclamineus* variety 'Beryl,' the long-time favorite, sulphur-yellow 'W. P. Milner,' and the lovely white *N. triandrus* variety 'Thalia.'

Narcissus must be potted early to give them a full period for root growth, and they must be watered very faithfully from

A pot of grape-hyacinths remain in bloom for a long time because each bulb produces several bloom stalks in succession. This is the white-flowered *Muscari botryoides alba*

This dish garden is composed of scillas, grape-hyacinths and small begonias, removed from their pots and replanted in an ornamental container

Roche

the time they are first taken indoors. Six of the smaller 'W. P. Milner' bulbs will fit in a 6-inch pan.

Star-of-Bethlehem (*Ornithogalum*). The varieties *O. balansae* and *O. nutans* are the best and easiest for forcing. Three *O. balansae* will go nicely in a 4-inch pan, and six *O. nutans* in a 6-inch pan. These small bulbs, which produce star-shaped green and white flowers, also should have larger inverted pans placed over them during the rooting period. *O. nutans* is so slow-growing that it does not have to be started outdoors but will grow in a cool room or under a cool greenhouse bench if kept well watered.

Lebanon Squill (*Puschkinia*). One of the most charming early spring bulbs, *P. libanotica*, a pale porcelain blue-striped with a deeper blue, is an easy and delightful subject for forcing. Planted four to five bulbs to a 4-inch pan, they respond readily to the general forcing treatment.

Scilla campanulata (below) is taller and later blooming than soft blue *S. tubergeniana*. It comes in white and tones of blue and rose

Scilla tubergeniana. Resembling *Puschkinia libanotica*, this delicate blue scilla comes into bloom very fast although it does not last as long as the other bulbs in this list. It may stay in bloom 12 to 14 days indoors. A 4-inch pan will hold three or four bulbs.

Spring Star-flower (*Brodiaea*). One of the easiest miniatures to force, *B. uniflora* and its variety *violacea* stay in flower a long time. They do not need an outdoor start but can be kept in a cool cellar or under a cool greenhouse bench until they begin to make top growth.

From long experience, Jean Thibodeau has discovered that there are a few miniature bulbs which do not force well. Amateurs are advised not to try *Allium*, *Camassia*, *Hyacinthus amethystinus*, *Ixiolirion*, and *Scilla campanulata*. All of the Dutch and species crocus and *Tulipa kaufmanniana* group force very easily, but they cannot endure the heat of a house and last briefly once brought to flower.

Potted Bulbs As Terrace Decoration

Hardy bulbs may be flowered outdoors in spring ornamental containers. One method of doing this used for these hyacinths—is to set pots of bul directly in them without removing plants from po

Wherever tubs will not freeze solid over winte plant crocuses directly in them. Otherwise, sto potted bulbs in sheltered frame for the winter

Yellow 'Mr. van der Hoef' tulips are effective grouped next to cream-yellow mollis azaleas belo

Jeannette Grossman

TULIPS IN THE GARDEN

Types and varieties for every use

Conrad B. Link

THE great brilliancy of spring color in the garden is provided by tulips. These plants are versatile in habit of growth and season of bloom as well as in size and color of the flowers. The color range in the flowers is practically the entire spectrum, except pure blue. This great variation gives the gardener an opportunity to use tulips in many ways.

In Formal Plantings

No other flower is so effective (except perhaps the hyacinth) for formal plantings. Formal effects are produced by planting the bulbs in regular geometric patterns, or irregularly in such a way that they appear about equal distances apart. Large beds of elaborate design, with squares, rectangles, triangles, circles, or more complicated patterns, are useful in large gardens. But in more modest gardens, groups of tulips are fine for color effect, even though used in smaller quantities. There may be a place for several long rows planted along a walk or driveway. One row is not very effective; but four or five rows, with the bulbs evenly spaced, make a long-remembered sight. In such plantings, usually only one variety or color is used; or if several are planted, they are arranged in groups or blocks to provide a pleasing combination or pattern of colors. It is important that the varieties be all of the same general class, and the same height. Tulips belonging to the Early Single and Double, Darwin, Cottage, and Breeder classes are most useful for such purposes.

In order to produce flowers at the same height it is necessary to plant all of the bulbs at the same depth. After the ground has been prepared and raked, the rows may be marked out and holes made with a dibble. All of the holes should be of the same depth, and the bulbs of uniform size. Bulbs are spaced 5 to 8 inches apart. A more elaborate method, involving a considerable amount of labor, is to excavate the bed to a depth of 6 inches, place the bulbs, and then cover them with soil. Deeper planting may be done in loose, well drained soil. Tulips planted deep do not form new bulblets as fast as when planted shallowly, and consequently will flower better the second year. If regularity of growth is not considered important, a trowel can be used for planting the bulbs; but it is difficult to make holes of uniform depth with a trowel. The plants will be at their best the first year. If the foliage is left to ripen, the bulbs will flower the next season. Annuals may be planted among the ripening leaves, and will soon cover the entire area.

For Cutting

Tulips are among the best flowers for cutting in the spring; and they should be placed in the garden where cutting will not spoil the picture value of the main plantings. The gardener who has an area set aside as a cutting garden is fortunate; but if cutting must be done from the regular plantings, the outdoor color display can be maintained by careful selection of the flowers to be cut. The tall-growing types, Cottage, Darwin, and Breeder, are ideal because of their long straight stems. The flower arrangement enthusiast enjoys using some of the less common types such as the Parrot varieties the Lily-flowered tulips, and the "broken" tulips such as the Rembrandts and the Bybloems.

In the Flower Border

Masses or clumps of tulips provide the mainstay of color in the flower border

Genereux

Tulipa dasystemon, a species, is a fine rock-garden bulb. There are several star-shaped flowers to a stem, soft yellow tinged green

during late April and May; and their place is taken by many herbaceous perennials and flowering shrubs in late May and June. All types are suitable; the taller-growing varieties are particularly effective in border plantings, but many of the smaller-growing tulip species also make a contribution. The taller ones are used toward the back of the border, the shorter ones at the front.

Species Tulips

The species tulips, or (as they are sometimes called) the "botanical" or wild tulips, are the most charming of this group of plants. They are most effective when planted in small clumps, and grow successfully in warm, rather dry locations. For these reasons they are especially well adapted for the rock garden; but many of the taller-growing species are a real addition to any flower border. The dwarf species, growing 6 to 10 inches tall, include *Tulipa australis, T. hageri, T. kaufmanniana, T. linifolia,* and *T. biflora* var. *turkestanica.* The taller-growing species, about 12 to 20 inches tall, include *Tulipa acuminata, T. chrysantha, T. clusiana, T. eichleri, T. marjoletti, T. praestans, T. saxatilis,* and *T. sylvestris.* The colors of the species cover a considerable range; among them are brilliant reds, yellows, whites, and combinations of these colors. Species tulips are planted 6 to 8 inches deep, and will last for several years without being disturbed, but they will not succeed in poorly drained soil.

Grossman

The Kaufmanniana hybrid tulip, 'Magnificent,' clear white marked with cherry-red, is shown here beside a clump of 'Springwood White' heather

The Tulip Chart on the opposite page is from "The Tulip Story," published by the Associated Bulb Growers of Holland, 29 Broadway, New York, N. Y.

A GUIDE TO TULIPS

EARLY TULIPS

SPECIES	HEIGHT	FORM	COLOR	COMMENTS
a) Fosteriana	12-16 inches	Single cups, very large	Vermilion; hybrids in shades of red, creamy white & orange	Red Emperor is best known hybrid. Princeps 10 days later.
b) Kaufmanniana	4-8 inches	Pointed buds, broad, flat flowers	Creamy white, outside marked with carmine	Also called Water-lily tulip & has many hybrids. First of all to bloom.
c) Praestans	6-10 inches	Broad, open flowers with pointed petals	Scarlet	Two or three flowers per stem. Fusilier, best known.
SINGLE EARLY	10-14 inches	Single cup	Rich red, orange, dark pink, yellow, white	Earliest of garden tulips. Fine for edging.
DOUBLE EARLY	10-12 inches	Cup, filled with rows of petals	Pink, reds, yellow, white, orange. Self-colored and variegated	Edging or mass plantings.

MID-SEASON TULIPS

MENDEL	16-20 inches	Large, single cup	Vivid; self-colored or edged with deeper or contrasting hue.	Especially for forcing.
TRIUMPH	16-20 inches	Large, single cup	All colors, some two-toned. Satiny.	Distinguished from Mendel by later flowering and greater range. Sturdy.
DARWIN HYBRID	22-28 inches	Large, single cups	Noted for shades of red.	Handsome large flowers on strong stems.

LATE TULIPS

PARROT	20-26 inches	Large, open flowers with petals twisted, curled & deeply fringed.	White, pink, red, orange, violet, yellow. Outside often tinged with green.	
DARWIN	26-32 inches	Large cups, squared off at base and tops of petals.	All colors, mostly self-colored. Satiny texture.	Sturdy, resistant to wind and rain.
COTTAGE	22-30 inches	Long, oval or egg-shaped. Bases often rounded.	Pastels & pastel blends, light hues of red, etc.	Diverse group in color and form. Graceful and sturdy.
BREEDER	24-36 inches	Long, oval, single cups	Orange, bronze and purple tones predominate; some reds; no white. Two and three colors may blend in a flower.	Vigorous and effective. Flowers covered with bloom, not shiny.
DOUBLE LATE	20-24 inches	Large cups filled with petals	Shades of red, violet, yellow, white and two-toned.	Also called Peony-flowered. Sturdy stems.
LILY-FLOWERED	20-24 inches	Slender, urn-shaped with long, curving petals that turn outward at tips.	Bright pinks, reds, rose, yellows, lilac, violet & white.	Graceful and elegant. Long lasting.
REMBRANDT	22-26 inches	Large, single squarish cups	Striped & streaked against self colors of Darwins. Fantastic combinations.	Plant in small groups. Color "broken" Darwins, somewhat less vigorous than Darwins.
BIZARRE	20-24 inches	Large, single cups	Yellow backgrounds striped or marked with brown and purple.	"Broken" Breeder and Cottage tulips. Little grown in U.S.
BIJBLOEMEN	20-24 inches	Large, single cups	White ground marked with violet, purple or rose.	"Broken" Breeder and Cottage tulips. Little grown in U.S.

TULIPS OLD AND NEW

An appraisal of varieties

Theodore Zellenrath

THE story of the tulip is rather well known to most people. The first bulbs found their way to Europe (particularly Holland) from the East, and what a sensation they made during the Seventeenth Century! What fabulous prices some varieties brought, too, enriching some, but ruining others, financially. Finally the Dutch government put a stop to it.

As late as the turn of this century—even in the early 1900's—many new kinds of tulips were discovered and brought into cultivation. There were such species tulips as *Tulipa greigi, kaufmanniana, eichleri, fosteriana* and *praestans*. We are chiefly indebted to the firm of C. G. van Tubergen of Haarlem, Holland, for bringing these tulips to Holland, as a result of their sending highly competent men to Asia Minor and Central Asia to collect them.

A few facts may be of interest, taken from the van Tubergen booklet about new introductions. In 1923, *Tulipa chrysantha* was introduced to Holland by an English officer who was enchanted by the beautiful effect this small yellow and red tulip made on the mountain slopes in British Afghanistan. The now-popular tulip 'Red Emperor' came in a collection of *T. fosteriana* from Bokhara in the autumn of 1904.

The best-known type of tulip is still the Darwin, which has been grown in gardens and parks for the last 40 years or more. New varieties are introduced every year. Some are improvements on the old ones, others are not too interesting. Where can one beat the beauty of the old favorites 'William Pitt,' 'Clara Butt,' or 'Pride of Haarlem,' for example. Still some newer ones are a real addition to our garden display, such as 'Queen of Bartigons,' a beautiful soft pink; 'Charles Needham,' a large vermilion-red; 'Pink Supreme,' very attractive pink; 'Royal Delight,' outstanding carmine, and many others.

The Darwin Hybrids

The new tulips classed as Darwin Hybrids, with their very large flowers, are exceptional. Most of them are hybrids of

No tulip in recent times has excited so much comment as 'Artist,' which is colored terra-cotta flushed with green through the middle of each petal

Malak

Roche

Above left. 'Texas Gold' is one of the more attractively formed Parrot tulips. The deeply laciniated petals are golden yellow, feathered with green. Blooms are large

Above right. 'Captain Fryatt' is of the Lily-flowered type. The color is dark ruby-violet with violet-blue at the petal base

Middle right. 'Blizzard,' the white Triumph tulip in the foreground, has thick leathery petals. This variety is reported to withstand bad weather better than most tulips

Darwins and the variety 'Red Emperor,' which accounts for the extraordinary size of flower, and earliness in blooming. Nearly all of the Darwin Hybrids are in shades of red. 'Lefebre's Favorite,' 'Apeldoorn,' 'Dover,' 'Spring Song' are some of the leading ones. The only yellowish hybrid is 'Gudoshnik,' which is a real beauty—creamy peach with deep rose petal edging.

Peacock tulips, obtained by crossing *greigi* and *kaufmanniana,* are a valuable recent addition to dwarf varieties for the early garden. They are very striking with their spotted center and banding of contrasting colors. The foliage is darker, with brownish spots. A bed or a large clump in the border cannot pass anyone's notice.

Lately, Lily-flowered tulips have gained the prominence which they very well deserve. They are exceptionally graceful. This class has developed many distinctive varieties, such as the older 'Captain Fryatt,' garnet-red, and 'Alaska,' a bright yellow. Later introductions, well worth growing are: 'Aladdin,' a very large scarlet with narrow yellow edge; 'China Pink,' elegantly formed satin pink; 'Dyanito,' with its attractive shape and brilliant red color; 'Philemon,' a large lemon-yellow of perfect form; 'White Triumphator,' the most beautiful large white tulip;

and last but not least, 'Queen of Sheba,' with its peculiar orange-edged brown petals.

Although they are not new, the Late Double or Peony-flowered tulips deserve to be better known. The older varieties, such as 'Peony Red,' are very pretty, but the more recently introduced varieties are absolutely exquisite. A few of these are: 'Eros,' beautiful old rose color, very double and long lasting; 'Nizza,' gay red and yellow feathered petals; 'Palette,' a real artist color of violet-red and enormous in size; and 'Uncle Tom,' attractive dark maroon, fully double and very popular.

Early Flowering Kinds

Not many new early tulips have been introduced lately. There is still nothing nicer than a large bed of the early single red and yellow 'Keizerskroon,' which was renamed 'Grand Duc' during the First World War. 'Bellona' is a very good yellow, and is good to grow inside during the winter. 'Great City' is one of the newer ones, very large, red with yellow edge. In Early Double tulips, we have grown many of the newer varieties and can recommend them all. 'Aga Khan' is a deep yellow, changing to orange; 'Bengalen' an orange-red with cherry-red; 'Colosseum,' a large sulphur-yellow; 'Fringed Beauty,' vermilion, attractively fringed with golden yellow margin; 'General Dean,' a striking scarlet. All these are very double and have a slightly taller stem than the older varieties.

Special mention should be made of the "green" tulips. Some of these have been listed for a long time, but they were never popular. However, 'Artist,' which is sometimes classified as a cottage tulip, is considered one of the outstanding green varieties, with its outside coloring of purple and salmon-rose and inside toning of salmon-rose and green. 'Greenland' is another worthwhile variety colored old-rose and green.

Mendel and Triumph tulips are not well known because the average person classes them with Single Early tulips. They bloom just after early tulips and before the Darwins. All varieties are ver good bedders, and most of them are wor derful for growing indoors in winte Mendel variety 'Fuga' is still one of th best reds, while 'Dreaming Maid,' of late introduction, deserves a place anywher with its large violet flowers, finely edge with white.

In Triumph tulips nothing can be 'Blizzard,' an outstanding creamy-whi variety of beautiful strong texture an enormous size. 'Garden Party,' a later in troduction of special quality, outshin many of the older ones, with its larg white flowers, edged deep carmine. 'Re Giant' is an old stand-by, and can b forced indoors as well as grown in th garden.

In Parrot tulips, almost any color ca be had, from black (or deep maroon) t red, pink, yellow, orange and blue, t multicolored. 'Karel Doorman,' ofte called 'Doorman,' is a cherry-red beaut with golden edge, while 'Double Fantas is a many-petalled form of the popula 'Fantasy.'

Hybrids derived from species tuli are getting more and more popula Among the Kaufmanniana hybrids of not are 'Alfred Cortot,' 'Oriental Beauty,' an 'Stresa,' all variations on the red an yellow coloring of *T. kaufmanniana.* A are very striking. Of the Fosteriana hy brids 'Cantata' and 'Princeps' are goo reds, while the recently introduced variet 'Purissima' and 'White Emperor,' a ver large white novelty, which flower with 'Re Emperor,' are now making a hit. A co lector's item is *T. acuminata* (*T. cornut* or *T. stenopetala*), with its odd-shape petals of red and yellow, which do n resemble those of a tulip at all.

Many new varieties of tulips and oth bulbs are introduced each year. They a the result of years of labor in hybridiz tion and testing. Only a few seeds fro a thousand produce worthwhile flowe after three years growth. Seedlings mu be grown for several years to test the for vigor, ability to propagate and eve their suitability for greenhouse forcin before they can be put on the market.

Iow to grow and use

)UTCH HYACINTHS

James S. Jack

SOMETIMES the hyacinth, one of our best spring-flowering bulbs, is quite nfavorably criticized, and rightly so, beause it produces a stiff, squat, shorttemmed and overly fragrant flower. But, nese very characteristics of the Dutch yacinth make it the ideal bulb for plantng in certain situations. The soldierly arriage, the uniformity of height and hape, and the fragrance, make these ulbs perfect for formal plantings, wheth-r in long ribbons of color that can prouce the illusion of distance in a large arden, in geometrical designs that dupliate, accent or complement architectural esign, or in patches of pastel tints in a mall flower border or city garden.

Dutch hyacinths need not be a one-year-f-flower planting, for they can be plantd outdoors and cared for in such a way hat they will continue to bloom for a umber of years. They do not, however, ultiply and continue to produce firstlass blooms like daffodils, for they will iminish in size each year—and there is o way to stop this. However, after two ears of good display of color in one spot, hey can be lifted and replanted in deep oil in another place, such as at the base f rocks, in a shrubbery border, grassy rea, etc., where they can naturalize and ontinue to produce daintier blossoms on lender stems, somewhat resembling wild yacinths.

To bloom again another year the folige of hyacinths must be permitted to ipen, to turn brown and dry out. The ulb needs to build up the flowering bud or next year within itself by drawing ll the nourishment from the leaves. In an area where the drying foliage will be unattractive, or where space must be created for transplanted annuals, the bulbs can be dug with the green foliage and roots intact, and cared for as follows: Lay them out on the ground in single layers, cover them with peat moss, leaves or any mulching material available, and leave them covered until the ripening process is completed. Then they must be uncovered to dry off completely and the dead foliage, dried soil, and loose roots should be removed. To store over the summer they should be laid out in single layers in slatted flats that permit air circulation, and stored where they are protected from rain until time for replanting

Gottscho-Schleisner

Iyacinths are planted in solid beds in conrasting colors in the formal garden of Mr. nd Mrs. Ricardo C. Gonzales, for whom Mr. Jack is superintendent

in the fall. It is a good plan to dust the bulbs with a fungicide before storing.

Like all bulbs, hyacinths like well-prepared and enriched soil. The size of the bulbs purchased determines the planting depth and the spacing. Each size of Dutch hyacinth bulb serves a specific purpose, and for the average gardener the sizes come down to three: miniature, medium and top-size. Some catalogs might call them small, bedding and exhibition. Each bulb dealer has his own terms. The miniatures, 5 inches *in circumference*, are good for the very small border, window box, or in combination with other dainty flowers, or in the rock garden. These miniature Dutch hyacinths should not be confused with scilla or grape-hyacinths. Plant the miniatures 10 to 12 bulbs to a square foot. Bedding or medium size bulbs are about 7 inches in circumference, and are best for all-round garden use. They should be planted 5 or 6 bulbs to a square foot, or 5 inches apart and 5 inches deep. The 8- or 9-inch bulbs are for producing exhibition quality flowers. Actually they are not practical for

Roche

outdoor gardening because the extremel heavy blooms are apt to need staking Even rain can make them topple an twist. This size is best used for forcin in pots in the greenhouse or porch.

Plant hyacinths in October or Novem ber before there is frost in the ground Newly planted bulbs should be covere with a light mulch of leaves, salt hay o strawy manure. Plant hyacinth bulbs i soil that has good drainage—in othe words, the plants do poorly if they hav constantly wet feet.

Striking designs and color combination are possible with the many colors an shades of hyacinths that are availabl One of the most beautiful color combina tions we have used was in a ribbon plant ing of deep blue, pale blue and snow white. The long rows produced an im pression of distance and the cool color a sense of peace. But for those who pre fer the more striking, more brilliant com binations there are available now blue that are almost purple, magenta reds bright yellows, and even deep salmon pinks. One-color gardens that vary fron the palest tones of pink or blue to th deep dark hues are always delightful, an of course a touch of white sets them off Always use the pale shades in front, dar ones in back, just as nature produces fo us the illusion of pale green at our fee and dark green far away, or pale blue o the low horizon and deep blue high in th sky.

It is pointless to list variety name here because each bulb handler offers i his catalog his own choicest varieties Good bulb dealers keep up with the pro duction of new and improved varieties The first important decision is to selec a reliable firm and *do not buy so-calle bargains* from unrecommended sources Incidentally, mid- to late-summer is th time to place your order for Dutch hya cinths; it can be done even earlier. Th early order gets the better bulbs.

Hyacinths left in the garden for more tha one year produce smaller blossom spikes, bu more of them—thus a less formal bed tha first-year bulbs

Frese

Forcing Hyacinths in Glasses

First step is to remove dead roots and all soil from the base of the bulb; also remove loose outer "skin" which might mold and rot, thus fouling the water, as above

Fill the glass with water just up to the base of the bulb, and keep in a cool, dark place until roots reach the bottom, and the top begins to grow. Then, before forcing into bloom, "stretch" the bud by covering with open top black paper cone, as shown. To lengthen blooming period, keep bulb out of bright sun, and move to cool room at night

Roche

Forcing Methods

For indoor forcing purchase "prepared" bulbs, that is, bulbs that have been treated in such a way by the bulb grower that they will force earlier and more uniformly. Medium-size bulbs can, of course, be used for forcing and actually are, for the most part, the most practical. If show quality is desired, purchase the exhibition size.

Medium size bulbs should be potted one to a 4-inch pot, two to a 5-inch pan, or three to a 6-inch pan. The top half inch of the bulb must protrude from the top of the soil. A soil mixture of one part soil, one part peat moss, and one part sand (and no fertilizer) is about right for indoor growing. Immediately on potting, which should be done as soon as possible after receiving the shipment, the bulbs should be placed in a dark location and held at about 50° F. Uniform temperature is important until root systems are established. Bulbs potted in late September, removed from the dark the latter part of November, and placed in temperatures of 65° to 70° F. will bloom late in December or early in January. On coming from the dark they need to be shaded with paper from strong sunlight until the flower shoots begin to grow. The ideal growing temperature is about 60° to 65°, and if they can be placed in a cooler spot once the color begins to show, it hardens or firms the blooms. Later planting or longer time in the darkness produces later blooms.

HOW TO RECOGNIZE TYPES OF DAFFODILS

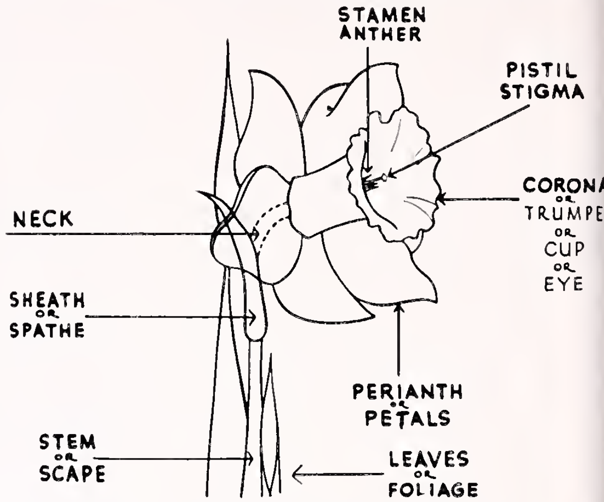
Shapes, sizes and colors of daffodil blooms vary so greatly that soon after the turn of the century it was found necessary to devise a system for their classification. Thus, in 1908 the Royal Horticultural Society o England developed a system which was use without change until 1950. The America Daffodil Society now uses this classification

Classification of some types of daffodils is based on the character of the flower parts identified in this sketch (right). Definitions of the basic parts of a bloom are as follows:

Trumpet, Cup or Corona: the center portion of the flower which varies in shape from long and tubular to a flattened disc

Perianth: The wheel or circle of petals surounding the central corona

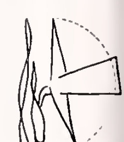
This accompanying illustration and the stylized sketches of blooms on this and the next page are reproduced by courtesy of Kingwood Center, Mansfield, O.



REVISED SYSTEM FOR THE CLASSIFICATION OF DAFFODILS

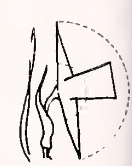
(i) "Colored" means yellow or some color other than white.
(ii) "White" means white or whitish.
(iii) The length of a perianth segment is the extreme length measured on the inside from its junctio with the corona along the midrib to the extreme tip, and the length of the corona is the extrem length measured from its junction with the perianth to the end of its farthest extension when th edge is flattened out.

Division I.
TRUMPET NARCISSI OF GARDEN ORIGIN.



Distinguishing characters: One flower to a stem; trumpet or corona as long as, or longer than the perianth segments.
(a) Perianth colored; corona colored, not paler than the perianth.
(b) Perianth white; corona colored.
(c) Perianth white; corona white, not paler than the perianth.
(d) Any color combination not falling into (a), (b) or (c).

Division II.
LARGE-CUPPED NARCISSI OF GARDEN ORIGIN.



Distinguishing characters: One flower to a stem; cup or corona more than one-third, but less than equal to the length of the perianth segments.
(a) Perianth colored; corona colored, not paler than the perianth.
(b) Perianth white; corona colored.
(c) Perianth white; corona white, not paler than the perianth.
(d) Any color combination not falling into (a), (b) or (c).

Division III.
SMALL-CUPPED NARCISSI OF GARDEN ORIGIN.

Distinguishing characters: One flower to a stem; cup or corona not more than one-third the length of the perianth segments.
(a) Perianth colored; corona colored, not paler than the perianth.
(b) Perianth white; corona colored.
(c) Perianth white; corona white, not paler than the perianth.
(d) Any color combination not falling into (a), (b) or (c).

Division IV.
DOUBLE NARCISSI OF GARDEN ORIGIN.

Distinguishing character: Double flowers.

Division V.
TRIANDRUS NARCISSI OF GARDEN ORIGIN.

Distinguishing characters: Characteristics of *Narcissus triandrus* clearly evident.

(a) Cup or corona not less than two-thirds the length of the perianth segments.

(b) Cup or corona less than two-thirds the length of the perianth segments.

Division VI.
CYCLAMINEUS NARCISSI OF GARDEN ORIGIN.

Distinguishing characters: Characteristics of *Narcissus cyclamineus* clearly evident.

(a) Cup or corona not less than two-thirds the length of the perianth segments.

(b) Cup or corona less than two-thirds the length of the perianth segments.

Division VII.
JONQUILLA NARCISSI OF GARDEN ORIGIN.

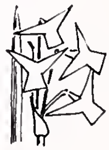
Distinguishing characters: Characteristics of any of the *Narcissus jonquilla* group clearly evident.

(a) Cup or corona not less than two-thirds the length of the perianth segments.

(b) Cup or corona less than two-thirds the length of the perianth segments.

Division VIII.
TAZETTA NARCISSI OF GARDEN ORIGIN.

Distinguishing characters: Characteristics of any of the *Narcissus tazetta* group clearly evident.



Division IX.
POETICUS NARCISSI OF GARDEN ORIGIN.

Distinguishing characters: Characteristics of the *Narcissus poeticus* group without admixture of any other.

Division X.
SPECIES AND WILD FORMS AND HYBRIDS.

All species and wild, or reputedly wild, forms and hybrids.

Division XI.
MISCELLANEOUS NARCISSI.

All narcissi not falling into any of the foregoing divisions.

KINDS OF DAFFODILS AND HOW TO GROW THEM

George S. Lee, Jr.

THE daffodil is an early riser with an amiable disposition. It is hardy, increases generously, comes in a surprising range of colors, shapes, and sizes; grows in any part of the country which has frost, and has relatively few pests. Once placed in the ground, a daffodil asks little attention.

Sooner or later someone will pose that venerable conundrum: what is the difference between a daffodil, a narcissus, and a jonquil? Brushing aside local usage and even more scholarly opinions, let us agree that daffodil is the common English name for the entire genus Narcissus and may be used interchangeably with the botanical name "Narcissus." Jonquils, on the other hand, are members of one small group within the genus, including the species, *N. jonquilla,* certain related species, and their hybrids. Call them all daffodils and you will never be wrong.

Daffodils may be grown and enjoyed with no knowledge of their classification. Sorting the named varieties into divisions and sub-divisions, however, provides fair competition at daffodil shows and enables dealers to bring similar varieties together in their catalogs.

The official grouping is best explained by the drawings on pages 44, 45. The first three classes are determined by the size of the trumpet or cup in the center of the flower, and each class has four sub-divisions for the different colors. Class 4 contains all the doubles, while each of the next five classes brings together the hybrids of certain species, *i.e., N. triandrus, N. cyclamineus, N. jonquilla, N. tazetta,* and *N. poeticus.* The first three of these have two sub-divisions determined by the length of the cup. Classes 10 and 11 contain species and wild forms.

Cultural rules are few and subject to considerable variation. A daffodil's home is in the ground to which it should be consigned as soon as received and not removed except briefly for division at long intervals. No daffodil bulb is improved by being kept out of the ground.

Deep preparation of the soil is needed since the large bulbs should rest at a depth of 6 to 8 inches and the feeding area for the roots is all below that level. In effect, the soil should be inverted, with the best quality soil below the bulbs. The need for fertilizer, if it exists, should be anticipated and the soil below the bulb enriched in advance of planting.

The acidity of the soil seems to be of little consequence. It may be acid or alkaline. Since the cycle of the plant above ground has been nearly completed by the time deciduous trees leaf out, the only shade to be avoided is that of evergreens and buildings. It must be emphasized, however, that the very life of the bulb depends on allowing its foliage to ripen and die down naturally after flowering. Moisture is rarely a problem unless the soil is waterlogged, in which even drainage must be provided.

Daffodils are not heavy feeders. A soil in which other plants grow well is likely to be rich enough for them. If the response of the bulb is not satisfactory, or if soil tests show important deficiencies, an annual feeding may be necessary. If so, any formula low in nitrogen and high in potash will answer; for example, a 5-10-10 analysis.

Potato fertilizer, which is inexpensive and may be purchased in rural areas, is excellent. I have had good results from a home-made mixture of more or less equal

parts of fireplace ashes (for potash), bonemeal, and superphosphate.

Much paper is used, and probably wasted, debating the best time to fertilize. Common sense seems to say that if the bulbs are growing in fertile soil, the roots will help themselves in accordance with the fluctuating appetite of the growing bulbs. All normal needs will be met with the least effort if a dusting of slow-acting fertilizer is applied to the emerging shoots in connection with the routine spring cleanup of debris.

Diseases

Daffodil bulbs are susceptible to a few diseases which are not very troublesome in the northern states, although their seriousness increases as we move south. The most widespread is a **virus infection** which reveals itself by striping, corrugation, or other abnormality of the leaves. No cure is offered; indeed, the means by which the virus spreads from plant to plant is not known for certain. The infection is not necessarily progressive and, at its worst, deterioration of the bulbs is quite slow. Fewer and fewer flowers may be one sign of the progress of the disease. As a sanitary precaution, destruction of badly infected bulbs is recommended.

Basal rot occurs in warmer regions. The guilty fungus may be attacked in a number of ways, some of which are complicated and dangerous. The easiest method is to burn infected bulbs and replant healthy stock in fresh soil.

Nematodes, or eelworms, will rarely occur in fresh plantings of bulbs purchased from reliable dealers. Rigid inspection here and abroad assures clean stock from suppliers. Infection is most likely to result from planting bulbs in infected soil. Fumigation of the soil is possible, but it is more practical to burn the bulbs and abandon the site.

Most gardeners in the northern half of the country can grow daffodils all their lives without encountering anything worse than a suspected case of virus. To assure this, plant certified bulbs in fresh soil, keep them from direct contact with the soil by a casing of sand, avoid heavy applications of nitrogen, and divide the bulbs only when necessary.

Daffodils and snow-white arabis provide a ribbon of bloom above this dry wall

Grossman

Grossman

Golden-yellow hoop petticoat daffodil (*N. bulbocodium conspicuus*) is a dainty rock garden plant. Leaves of this species are round. Height is 4 to 6 inches

Genereux

Angel's tears daffodil (*N. triandrus albus*) usually bears several creamy white nodding flowers on each stem. It is good for rock gardens where it lasts a long time

Varieties

There is no more need to depend on the judgment of others as to the daffodil varieties you should grow than the books you should read or the music you should hear. If you have outgrown the old double 'van Sion' and 'King Alfred,' are ready for new adventures, and do not have easy access to a representative public or private collection, then study the catalogs of a number of dealers in bulbs. To sample the wide range and learn which forms appeal to you, try one or more varieties from each of the classes and sub-divisions. The result is likely to amaze you.

The catalogs of specialists will skip nimbly from a dozen bulbs for a couple of dollars to single bulbs for possibly fifty dollars. It will be found that the most satisfactory varieties for garden decoration are the cheapest. It is these which have pleased gardeners over the years and are in ample supply. A selection of the lower priced, named varieties should be the start of any collection of daffodils.

It will not take long to learn that the large yellow trumpets are early and a good deal alike; that the *N. poeticus* in Class 9 are very late and also quite similar to one another; that the most spectacular color combinations of red, yellow, and white, are found in Classes 2 and 3; and that many of the all-white, small cups with green eyes in Class 3 are extremely late and lovely indeed. Some of the most attractive and easily grown flowers are to be found among the *triandrus, cyclamineus,* and jonquil hybrids in Classes 5, 6, and 7. Here are the multi-flowered, fragrant, and nodding forms, unfamiliar to so many. Most gardeners will presently develop a special fondness for certain colors or forms; it may be the whites, the so-called "pinks," the showy garden varieties, the fragrant jonquil hybrids, or, among more advanced amateurs, the exhibition types, miniatures, or species.

The "pinks" are still in the laboratories of the hybridizers and the sensational results the name implies should not be anticipated. They do better in the North-

west than the Northeast, in partial shade than full sun, in some years than in others.

Miniatures are usually considered to be those flowers which do not exceed 8 inches in height. They are all either species, or only a generation or two removed from the species. For that reason they prefer a facsimile of the gritty, lean, dry soil of their native mountains bordering the Mediterranean. A rock garden will often do very nicely.

The length of the flowering season varies considerably with latitude. From Washington south, *bulbocodium* hybrids may come into bloom in December with the peak season in March and April. Around New York there can be flowers in abundance from late March to mid-May.

It is a rather loose rule that the earlier varieties do better in the South than the *N. poeticus* and most of Class 3, the short cups, which are relatively late. In addition, the jonquils and tazettas find southern conditions greatly to their liking. A heavy mulch will help bring through those types which dislike a long, hot summer.

The only varietal limitation in the North is that daffodils with tazetta "blood" and the bulbocodiums are apt to be a bit tender.

Where to Plant

Plant them in clumps in the perennial border or in the foreground of shrubs, naturalize them in fields or open woods, grow them along a path or against the background of a fence or wall. By all means plant clumps of early-flowering forms where they can be seen from the house, especially the kitchen, and set out a few to greet the visitor at your door.

Plant daffodils everywhere and any way, except as single bulbs in a pattern of straight lines. A geometrical arrangement is permissible only when the flowers are being grown for comparison or study, rather than enjoyment. Mixing varieties is equally unsatisfactory, although pleasing contrast is obtained when neighboring groups differ. Around most homes the best effects are achieved by the irregular planting in separate clumps of three to a dozen bulbs each of contrasting varieties.

Naturalizing Daffodils

Daffodils naturalize well in rough grass and under deciduous trees. To plant them this way distribute the bulbs in informal groups or drifts on the ground, and set bulbs 6 inches deep in holes made with a mattock. At right, a naturalized planting in bloom

Frese

Gottscho-Schleisner

SMALL FLOWERING BULBS

Barbara M. Laking

FOR those who live where there are long flowerless winters, the small bulbous plants that appear in early spring are treasured most. A small drift of winter aconite (*Eranthis hyemalis*) with yellow buttercup-like flowers in early spring, or a pocket of netted iris (*Iris reticulata*) with its violet-like fragrance, mean more than a hundred tulips later in the spring.

In commenting on the many kinds of small bulbous plants, I am including chiefly true bulbs, and also some lovely kinds that are not true bulbs, but whose bulb-like parts are planted in autumn. For example, the winter aconite "bulb" is not a bulb at all, but a tuber, the crocus, a corm.

The species and varieties referred to here have been selected and listed in order of flowering, from spring to fall, as observed at the Royal Botanical Gardens, Hamilton, Ontario. The notes that follow were made at these Gardens.

Malak

Crocus

I particularly like some of the named varieties of *Crocus chrysanthus*. Flowers of species crocus are smaller than those of the ordinary large-flowered (hybrid) garden crocuses, but they are borne in the utmost profusion and usually much earlier. Many species grow well in the rock garden or in a sunny location away from tree roots. Good varieties of *Crocus chrysanthus* are:

'E. A. Bowles'—butter-yellow, exterior base brownish-gray tinged, very large flowers.

'E. P. Bowles'—color slightly darker, exterior purplish, feathered.

'Snow Bunting'—pure white with golden throat, exterior purplish, feathered.

'Canary Bird' — small, yellow flowers produced in great quantity.

Large Dutch hybrid crocuses will grow and flower freely in almost any soil or position, increasing in beauty from year to year with little attention. These hybrids are excellent for mass plantings, in groups in the front part of the perennial border, or naturalized in drifts in grass. For those wishing to naturalize them in the lawn, it is important to know that the crocus foliage should die back before the grass is cut. This means an unkempt lawn for more than a month after other lawn areas are mowed in spring.

There are many fine varieties. Most effective in our Ontario climate are 'Queen of the Blues,' with very large ageratum-blue flowers of great substance; 'Joan of Arc,' pure white; 'Largest Yellow,' brilliant yellow, early; *Crocus purpureus grandiflorus*, rich, purple-blue.

'Pickwick,' a new variety of crocus, is a pale silver lilac color with deep lilac stripes

Glory-of-the-Snow (*Chionodoxa* species)

Chionodoxas do best in the sun, but will succeed in partial shade of deciduous trees and shrubs. A patch or drift of these graceful starry-flowered bulbous plants makes a cheerful display in early spring. They grow very well in a pocket of good soil in the rock garden. The foliage dies down quickly after flowering, and does not spoil the effect of later-flowering plants. Here are the species one should know.

Chionodoxa gigantea—large, light blue flowers.

C. luciliae—bright blue, white center, often eight flowers on a stem.

C. sardensis—true gentian blue, rich color, small white center.

Squill (*Scilla*)

Since scillas emerge and flower early and their foliage dies down by early summer, they can be planted in pockets of soil or under or near deciduous trees and shrubs without ill effect, as long as they have plenty of sunshine before being shaded by overhead plants. We grow them each year in small pockets, planted among and directly in front of *Tulipa praestans* var. 'Fusilier,' the scarlet multi-flowered tulip. The color combination of blue and scarlet is gay, and during most seasons, their flowering periods overlap for one or two weeks. Such groups brighten an evergreen planting, and can be used in the rock garden or in any sunny front position where there is a background of other plants.

Scilla sibirica 'Spring Beauty' has rich deep-blue flowers and is superior to the ordinary species in form, size and depth of color.

Snowdrop (*Galanthus*)

Snowdrops seem to thrive best when associated with deciduous trees or shrubs. Because they bloom very early, a few planted in an intimate part of the garden are most rewarding.

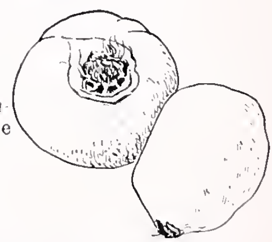
Galanthus nivalis, the common snowdrop, is best grown in woodland

Grossman

Chionodoxa gigantea is a charming bulbous plant with 6-inch stems and clear blue flowers that open in early spring

Bulbs of the chionodoxa—natural size

Bulbs of *Scilla hispanica*—½ natural size



The bright blue blossoms of early-flowering *Scilla sibirica* are charming in special situations. About 6 inches high *Roche*

Roche

Blooms (above) of *Leucojum aestivum*, summer snowflake, and the bulb (left) —2/3 natural size

McFarland

plantings or in the rock garden in a sheltered place.

G. nivalis flore-pleno — green-tipped double flowers. Very effective in mass plantings of several hundred bulbs.

G. elwesi, giant snowdrop, beautiful large-flowered snowdrop from Asia Minor. Does best with plenty of sun.

Snowflake (*Leucojum*)

The spring snowflake is larger, far more vigorous than any of the snowdrops, and is easy to grow. Snowflakes are good border plants if grown in bold groups. Their narrow foliage and nodding blooms which extend above the tips of the leaves contribute to their effectiveness when naturalized in semi-wild gardens. They are also suitable in pocket culture in rock gardens.

Leucojum vernum, the spring snowflake, has white nodding flowers, usually one to a stem. Each white petal is tipped with its characteristic spot of green color.

L. vernum var. *carpathicum*, yellow-tipped variety, is rightly considered the more attractive of the two. It generally bears two flowers on each scape. They both bloom about one month after snowdrops.

Grape-Hyacinth (*Muscari*)

Grape-hyacinths are ideal for edges of borders, for front positions in perennial borders or shrub borders, and for naturalizing in sunny places in a wild garden, where they give a good solid mass of blue

Clear blue grape-hyacinth *Muscari armeniacum* (left) and bulbs (below)—½ natural size

color. They should never be planted in the rock garden proper, but should be kept well on the outskirts, because their foliage is a nuisance most of the season and the plants multiply very freely by bulb and seed thus choking out some of the choicer rock garden plants.

Muscari armeniacum—flowers deep cobalt-blue with distinct white rim; there are many spikes per bulb. Excellent for massing.

M. armeniacum var. 'Cantab' — very pretty variety, flowers bright clear Cambridge-blue. Very free-flowering.

Winter Aconite (*Eranthis*)

Winter aconites are best planted where they can be left undisturbed for many years. They need plenty of sunshine in the early spring months, and though they do best by themselves in drifts or soil pockets, they are quite satisfactory planted beneath deciduous shrubs.

Eranthis tubergeni var. 'Guinea Gold' has large, deep golden-yellow flowers like buttercups, on short stems, each surrounded by a frilly ruff-like bonnet. Sweet scented. Later than and far superior to the species *Eranthis hyemalis.*

Iris (small bulbous types)

Iris reticulata and its varieties are the best of the bulbous types of irises for cold temperate climates. They are very effective in small clumps in the rock garden, particularly if given a spot sheltered from the spring winds. Even when flowering they withstand sharp spring frosts without harm, but excessive exposure to wind tatters the blooms and shortens their life.

Iris reticulata has dark purple-blue flowers with bright orange crest, and the fragrance of an English violet.

I. reticulata var. 'Cantab'—pale blue flowers with orange blotch. Large flowered.

I. reticulata var. 'J. S. Dijt'—fine hybrid with reddish purple flowers, which are sweet-scented.

Tulip (*Tulipa*)

The smaller species tulips, which are early and brilliantly colored, are invaluable in the garden in late April and early May. There is no need to grow them by the hundreds. A cluster of six, in blossom in late April, gives as much pleasure as a whole bed of tulips in mid-May.

They grow well in warm, sunny, well-drained spots, in the rock garden, on top of dry walls, or in intimate settings adjacent to patios or walks.

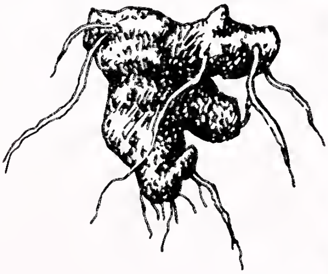
The following species and varieties do well for us in our Ontario climate:

Tulipa eichleri—large, bright, glossy scarlet flowers with yellow marginal blotch.

T. fosteriana var. 'Princeps'—very fine large red flowers on short stems; wide leaves, grey-green in color.

Genereux

Winter aconite, *Eranthis hyemalis*, is one of the first spring flowers. Tuberous root is below —2/3 natural size



The autumn-blooming crocus-like flowers of *Sternbergia lutea* are golden yellow. Bulb is at right—2/3 natural size

McFarland

We like to group *T. fosteriana* 'Princeps' with the even shorter cream and red *T. kaufmanniana* 'Vivaldi,' the fiery scarlet *T. praestans* 'Fusilier' and *Scilla sibirica* 'Spring Beauty' for rich blue contrast. Their flowering time overlaps and they provide a charming display for an intimate sunny spot in the garden—for example, in planting bays left for such purposes in foundation plantings, where they can be lifted after flowering and the bulbs ripened in the reserve garden, their places being filled with brilliant annual flowers.

- *T. kaufmanniana* var. 'Scarlet Elegance'—very bright variety with numerous small scarlet flowers.
- *T. kaufmanniana* var. 'Vivaldi'—creamy-yellow outer petals with crimson blotch, distinct crimson ring in center of the flower, leaves with brownish dots.
- *T. praestans* var. 'Fusilier'—a glorious multi-flowered tulip, with 4 to 5 vermilion flowers on a stem.
- *T. tarda*—a dwarf-growing species with myriads of yellow flowers with white tips, opening like stars. Usually has 3 to 5 flowers to each stem. Charming in the rock garden.

Sternbergia

Sternbergias flourish in a sheltered sunny place. They should be left undisturbed after planting.

Sternbergia lutea—rich yellow crocus-like blooms in autumn.

Malak

'The First,' a *Tulipa kaufmanniana* hybrid. Its color is pure white with an exterior band of crimson. Very early blooming

A SELECTION OF DEPENDABLE HARDY GARDEN LILIES

Charles Alexander Best

LOOKING back at nursery catalogs of just ten years ago, one notices in them very few of the hybrid lilies which are widely grown today. The reason is that lily breeding and development on a large scale has come about mainly in recent years.

Many of the 80-odd species of the genus *Lilium,* or true bulbous lilies, are of more interest to plant collectors and botanists than they are to gardeners. Whereas some exotic species, such as the royal lily (*L. regale*) and the Henry lily (*L. henryi*) are successful in many parts of North America, many native species, when removed from their own geographic area—as West Coast lilies moved to eastern U. S. gardens—do poorly. But when these same species are cross-bred, they often produce hybrids which are vigorous, adaptable, and which virtually any gardener can grow successfully. In the selection of these lilies currently available the range is from small and dainty types to large showy kinds, and the blooming season in eastern Canada and the United States extends from early June until frost.

Among the species, the coral lily (*L. pumilum*) is highly regarded for its graceful early bloom. This dainty reflexed lily grows from 18 to 36 inches high and is useful for planting in clumps in the border, in rock gardens, and for cutting. The upward-facing star lily (*L. concolor*), orange or red in tone, blooms at much the same time as the coral lily, and the very graceful *L. cernuum*, a pale lilac-pink and nodding Asiatic native, comes in late June or July.

Among North American native lilies the meadow lily (*L. canadense*), and the turkscap lily (*L. superbum*), have proven most adaptable to garden use. They can often be naturalized in grass or among low-growing shrubs or in the partial shade of trees, provided the soil is reasonably rich and contains an ample supply of humus. The graceful bell-like form of the meadow lily, and the tall and later blooming red-gold or turkscap lily, are great attractions during July.

A late summer succession in the species should include the Japanese goldband lily (*L. auratum*), particularly its variety *platyphyllum*. This lily is indeed gorgeous with its great bowl-shaped crimson-spotted blooms with gold or red bands running down each petal. If healthy, well-rooted bulbs are obtained and then planted and protected from virus disease by regular spraying for insect control, this lily may give several years of splendor. It is, however, quite susceptible to basal rot and virus troubles, and these have rightly given it a bad reputation. The later blooming showy Japanese lily (*L. speciosum*) provides more reliable color in August and September. 'Red Champion' is a good color form, basically white and pink, with deeper crimson markings. Its companion form 'White Champion,' slightly later in season, has a pure and glistening effect.

A host of new and vigorous hybrids have added great breadth to the lily world in recent years. The greatest number of these bloom throughout the month of July and the ones described below are regarded by this author as giving an excellent variation of color and form together with strong and adaptable growing ability.

'Destiny' and the Citronella strain are two excellent yellows from Jan de Graaff of Oregon. The former, with its upward-facing blooms and luxuriant foliage on

Grossman

Golden Clarion strain lilies are dramatic when planted with dark evergreen background

2-foot stems, presents a very effective picture. The Citronella group are taller with nodding flowers and make excellent cut flowers in July. 'Enchantment,' one of the earlier named de Graaff hybrids, is still regarded as an almost indestructible type certain to give a great show of color, with its soft orange blooms and clump-forming habits. 'Ruby,' an outstanding Canadian hybrid from Percy Byam of Toronto, is much the same in general effect but of a deep, glowing garnet shade. 'Brenda Watts,' a tall and recurved Canadian hybrid created by the distinguished plant hybridizer, Miss Isabella Preston, is perhaps the best known of the "Stenographer Hybrids." Useful for general border work, this lily, and its relatives, was part of pioneer progress in the genus.

From the Canadian West comes an unusual group of hardy pink and rose-toned hybrids, developed by Dr. C. F. Patterson of Saskatchewan. 'Edith Cecilia' is perhaps the most graceful of these and the dainty soft-pink blooms have attracted attention and awards throughout North America and the United Kingdom.

The Best Trumpet Lilies

The trumpet lilies have always been admired for mid-summer beauty. The Olympic hybrids from Jan de Graaff are generally the best strain of trumpet lilies now available to gardeners. Tall, more vigorous and with larger blooms than the species *L. regale*, these give a succession of blooms in cool white and cream tones through most of July. Through the process of constant selection and breeding, the Pink Perfection strain of trumpet lilies has been developed; with soft rose and pink colorings, they are an excellent addition to the Olympic hybrids. Yellow or golden trumpets have gained great popularity as they have become available in the past four or five years. Golden Clarion is the best all-around strain in this field and its tall, vigorous stems and heads of golden yellow blooms add fragrance and distinction to the garden scene during July. A recent development in the trumpet lily field has been the search for lime or green shades and the new Emerald strain is an excellent achievement in this direction.

The meadow lily, *L. canadense*, is one of the best species to grow in gardens. It does well in partial shade

Roche

Most of these trumpet lilies are part of a new and outstanding group of hybrids called the Aurelians, developed by crossing various trumpet species with the Chinese native *L. henryi*. Aurelians come in cream to apricot shades and in trumpet to reflexed form and give color from six to eight weeks during the summer. The gardener can find wide variety of form and season in the clones and strains developed by breeders within this group.

For August, the Golden Sunburst strain, semi-reflexed in form, with tall graceful stems, provides much interest.

Lilies are mostly native in temperate regions, thriving best where they can obtain a definite dormant or cooler period. Their scaly and somewhat loosely-formed bulbs require well-drained, friable soils. Most kinds, particularly the hybrids, tolerate a wide range of sun and shade. Generally, plants which are growing in sunny locations will be more vigorous. A number of the more difficult species, including many of our wild North American native lilies, must have plenty of humus in the soil, a partially shaded location and, if possible, a reliable source of moisture.

Fifteen Good Lilies to Try

Name	Blooming Season	Color	Height in feet
L. auratum platyphyllum	late July-August	white, crimson spotted	3-6
Brenda Watts	early July	orange-red	5
canadense	July	golden-yellow	4-6
Citronella	July	yellow	4
Destiny	July	lemon-yellow	2½
Edith Cecilia	July	pink	3
Enchantment	July	soft orange	2
Emerald strain	July	cool, lime-white	5
Golden Clarion	July-August	golden-yellow	4-6
Golden Sunburst	August	lemon-gold-yellow	5-7
Olympic hybrids	July	cream-white, green or bronze reverse	4-6
Pink Perfection	July	white, pink, rose shading	4-6
pumilum	June	coral-red	2-3
Ruby	June-July	deep red	2
Red Champion	August-September	white overlaid pink and red	3

COLCHICUMS PROVIDE AUTUMN BEAUTY

George L. Slate

COLCHICUMS are large crocus-like flowers that bloom in autumn when color is scarce in the garden. Although the flowers resemble very large crocuses and are often called autumn crocus, the similarity is superficial. Colchicums belong to the Lily Family and the flowers have six stamens, whereas crocuses belong to the Iris Family and the flowers have three stamens. What is usually called the bulb is a tunicate corm which produces large coarse-appearing leaves in the spring. These die down in June.

The naked flowers, which are long slender crocus-like tubes, appear in September. The individual flowers are short-lived, but more keep coming, so that for several weeks a well established plant or colony of several plants is a striking sight. The flowers are mostly shades of rosy-lavender, but there are two white varieties.

Although the flowers come in autumn, the seed capsules do not show up until next spring when they may be found in the cup formed by the bases of the inner leaves.

Most of the species are native to the Mediterranean region and western Asia, but they are fully winter hardy in cold central New York State where I have grown them for many years. They apparently have no special soil requirements and succeed in a rather stiff silty clay loam with a pH above 7.0. Good drainage is essential, which is true for most bulbs from the Mediterranean region. They grow well in full sun and also in partial shade.

Colchicum autumnale is the species commonly grown. It is rosy lavender in color and attractive, although not as handsome as the large-flowered hybrids of *C. speciosum*. A double-flowered variety is offered by bulb specialists. The pure white *C. autumnale album* is attractive if a few plants are included in a planting of the lavender type. The darkest colored variety is *atropurpureum*.

C. speciosum is much larger and the chalice-shaped flowers, varying from rose to purple, are very handsome and spectacular in the garden. *C. bornmuelleri* is a larger and earlier form of *C. speciosum* with lilac flowers and a conspicuously white throat.

The pure white variety of this species, *C. speciosum album*, is one of the most beautiful of hardy bulbous plants. Of it E. A. Bowles, one of the greatest of English gardeners, has written in his book "A Handbook of Crocus and Colchicum for Gardeners" . . . "The snow-white goblets of good form, equal to that of a tulip, standing on soft emerald tubes cannot be equalled for beauty in the late autumn by any other plant so easy to grow well in the open."

Incidentally, this fine colchicum was produced by Messrs. Backhouse's Nurseries at York, England, the same firm which produced the many fine daffodils and the series of lily hybrids known as the Backhouse hybrids.

Two checkered, or tesselated varieties with a color pattern like tiny checkerboard squares are *C. agrippinum* and *C. variegatum*.

Several hybrids, of which I have grown nine, are offered by nurseries. These are very similar, being rosy lavender in color, but varying in time of bloom. With some the flowers are floppy, while with others they are fairly erect. All are much larger than *C. autumnale* and any are worth having. My preference is for 'Premier,' 'Autumn Queen,' 'Violet Queen,' and 'Lilac Wonder.'

'Waterlily,' a double flowered variety, is

somewhat of a monstrosity, but it does provide a splash of color for a few days after the others have faded.

The Spring Foliage

The large, unattractive floppy leaves, which grow rapidly in spring, make colchicums difficult to use in conspicuous places in the garden. As the leaves fade in late June they turn yellow and sprawl on the ground. Even though the leaves are untidy at this time they should not be removed until they have turned brown in July. As long as they are green they are manufacturing food and fattening up the bulbs for better flowering in autumn.

In the garden they are good foreground plants for fall-blooming Japanese anemones, fall asters and chrysanthemums. Since the naked flowers need the greenery of other plants as a background to display their beauty, ground covers such as vinca or pachysandra may be used to provide a setting, support the long tubes, and protect them from being splashed by beating rains. The plants stand competition well and may be grown in grass or the wild garden.

A planting depth of 2 to 3 inches to the top of the corm is sufficient. About 6 to 8 inches between corms is enough for a good display and several plants in a colony are better than single plants scattered throughout the border.

Stock from dealers should be received and planted in August, otherwise the corms will bloom without being set in the ground as they do not need soil and moisture to flower.

The plants increase by division of the corm and eventually crowding results in weak foliage and sparse flowering. When this happens after several years the clump should be dug and divided. This should be done as soon as the foliage dies down. The corms may be replanted immediately or held in a dry well-aerated place in shallow open trays until not later than September 1.

Colchicum corms are the source of the drug colchicine used in the treatment of gout and in plant breeding to change the chromosome complement of plants.

Showy blooms of *Colchicum speciosum* are attractive against foliage of plantain-lilies

Grossman

A simple guide to

GROWING BETTER GLADIOLUS

Arthur R. Buckley

TWO things to consider before ordering gladiolus for spring planting are the selection of varieties and the size of the corm. Buy well recommended kinds and top-size corms, which should be 1½ inches in diameter.

In Canada and the United States, gladiolus "bulbs" (as corms are often called) are measured according to their *diameter* rather than circumference. Most people can tell at a glance if a bulb is 1 to 1½ inches across but to tell the circumference of a bulb is more difficult. Many corms are advertised as being over 2 inches in circumference; in reality these would be small corms.

Inspect the corms before planting by peeling off the outer husks entirely. Corms that are soft and mushy or have dark spots or any appearance of disease should be discarded and burned. No treatment will cure a diseased corm. If they are planted, the disease will eventually spread to other corms and will remain in the ground for many years.

Where to Plant

Gladiolus will grow in any soil where they are not shaded or where the soil is not wet. The vegetable garden is a good place to grow them in rows for cutting. However, keep them away from beans. The gladiolus might contain a latent virus disease which insects will soon spread to the beans. Ususally the beans are the losers but occasionally gladiolus will get virus from beans.

Gladiolus may be planted in the border with other plants, but one must make sure they are not crowded. Plant in small groups to give a dramatic effect to the border. Like most plants, gladiolus does best in a deep mellow soil. They are more prone to become diseased in an over-fertilized soil.

When to Plant

Planting time depends upon the climate in which they are grown. For large corms this may be as soon as all danger of late frosts is over; this is usually from early May until the middle of the month in the northern part of the United States. Cormels (very young corms) may be planted much earlier than this since they germinate slowly and benefit from the cool moist soil conditions. In climates where a very early killing frost may be expected, the corms are usually started inside for two weeks to get them sprouted before planting in the garden. This ensures blooms before fall frost. A series of plantings from early May to the end of June will spread flowering over a long period, but the selection of early, mid-season and late varieties will give a better flowering stretch with less trouble.

Pre-planting Treatments

The need for pre-planting treatment of corms depends upon whether they were dusted with an insecticide during storage or whether new ones were purchased. Corms bought from a gladiolus specialist will have been dusted during the winter. This can be spotted by examining them closely; if they have been dusted, some of the dust should still be adhering to the corms. If they have not, they should be dipped in order to destroy thrips. This insect is a serious pest of gladiolus that destroys the blooms and either prevents them from opening properly or so disfigures them that they are useless for cutting.

The simplest dip to use is ordinary household Lysol. Use this at a strength of 1½ tablespoons to one gallon of water and leave the corms in the solution for three hours only, then plant right away—

The gardener who grows a large collection of gladiolus varieties should label each kind as it is planted in a 6-inch-deep trench

do not leave overnight in a wet condition. If it rains and planting is impossible after dipping, wash the corms well in clear water and plant the next day. It will not be necessary to re-dip them since the thrips will already be destroyed.

Planting Methods

The usual way to plant is to dig out a trench 6 inches deep and plant the corms 6 to 10 inches apart, in rows 18 inches to 2 feet apart. If the soil is heavy, cover the corms with just 2 inches of soil at first and fill in the rest after they have sprouted. By planting deeply there will be little need for staking unless they are being grown for exhibition. Corms may be spaced as little as 3 inches apart but the flowers will not be as large.

Fertilizing

If your soil is reasonably good, don't use much fertilizer, especially nitrogen, as this often encourages disease. Superphosphate in the trench below the corms is good but should be covered slightly so that it does not come into contact with them. During the growing season, after the plant has five leaves, fertilize with chemical garden plant food at the side of the row (6 inches from the plants) and water it into the soil thoroughly.

Cultivation

Cultivation should be shallow so as not to disturb the roots. Or, cultivation may be eliminated with an inch mulch to keep down weeds and conserve moisture. Straw, shavings, or sawdust may be used as a mulch on light soils.

Watering

If the weather is dry, after the plants have formed five leaves, copious supplies

Keeping gladiolus weed-free with a "Barker Hoe." This tool runs like a lawn mower, is light weight, and is effective on light, stone-free soils

Author photos

McFarland

Before freezing weather, dig gladiolus corms by loosening soil around roots with a spading fork, lifting out corms by their still-green leaves. Cut off leaves close to corms, which are then dried

of water should be given. Water will do more good than fertilizer in producing large straight spikes of bloom.

Spraying

As soon as the plants are 5 to 6 inches high they should be sprayed every ten days, preferably using first 50% wettable DDT and then malathion, with an odd application now and again of lindane and nicotine sulphate to control other insects that DDT will not kill. Thrips are the worst insect enemy of gladiolus. They can mar the blooms and render them useless. If the blooms do not open properly or their color is streaked or weak, then the chances are that thrips are causing the damage. By this time it is too late to control them. So keep the sprayer working all summer and dust the corms in winter.

Cutting Blooms

When cutting flower spikes, cut the stem on a slant downwards between the leaves, and at the same time lift the spike upwards using the other hand. Leave four leaves on the plant to aid in the development of next year's corm.

Digging

Digging the corms may be done 4 to 6 weeks after blooming. In the north temperate zone this is usually from October 1 to November 1. Loosen the roots with a fork and then pull up the plants and cut off the tops close to the corms. Place the corms in a flat immediately and dust over them with 5% DDT. At digging time the air may be full of adult thrips flying about seeking a place to lay their eggs—which *could* be your flat of corms.

Curing, Cleaning, Storing

Cure the corms in a warm dry, airy

Author photo

Corms in stacked flats, stored for the winter in the author's basement. 2-inch pots between flats allows free flow of air

New gladiolus corms replace old ones during the summer growing season. Number of new cormels that develop at the base will vary by variety

Paris Trail

place in the cellar for a few weeks until the old corm and the roots pull away easily from the new corm. This may be about the end of November. After cleaning, place them in paper bags, labeled as to variety. In each bag, add a teaspoon of 5% DDT dust—then shake the bag well and take out the corms. Avoid inhaling any dust. After cleaning and dusting, store the corms in trays in a temperature of from 40 to 45° F. The trays may be stacked one upon another if blocks are placed between them to allow air circulation.

Recommended Varieties

White or Cream: Florence Nightingale, Leif Erickson, Antarctic, Snow Velvet, Green Ice, Ares, Lorelei.

Yellow: Catherine Beath, Forsythia, Fort Knox, Golden Boy, Golden Sunshine, Prospector, Taptoe, Yellow Spire.

Buff and Orange: A. B. Coutts, Atlantic, Cronus, Herald, Patrol, Wax Model, Vivaldi.

Salmon: Bermuda, Boldface, Melodie, Polynesie, Salmon Queen, Sundown, Wax Canary.

Light Pink: Clarence D. Fortnam, Coronation, Ethereal, Evangeline, Joanie, Pink Harmony, Temptress.

Medium and Deep Pink: Alfred Nobel, Boudoir, Diane, Friendship, Loretta, Maytime, Paul Bunyan, Spic and Span, Summer Queen.

Scarlet: David Warr, Dieppe, Redskin, Sans Souci, Viking, Welcome.

Light and Medium Red: Malabar, Medalist, Oscar, Radiance, Red Charm, Redcoat, Red Radiance, Royal Stewart, San Antonio.

Black Red: Ace of Spades, Black Opal, Congo, Dark David, Dark Brilliance, Jack of Spades, Top Hat.

Rose: Astrid, Burma, Director, Elmer's Rose, Innocence, Jolicoeur, Joyous, Pink Diamond, Rose Spire, Traveler.

Lavender: Bridal Orchid, Elizabeth the Queen, Francesca, Heirloom, Lavender Beauty, Parade, Princess, Royal Lavender, Wedgewood.

Purple: Emperor, King David, Purple Jet, Rockley King, The Rajah, Wonder Boy.

Violet: Blueberry, Blue Diamond, Blue Goddess, Blue Peter, Caribbean, Gratia, Majolica, Pinnacle, Violet Charm.

Smoky Tones and Polychromes: Allah, Blue Smoke, Brown Lullaby, Candy Kid, Mandy, Prunella, Smoky Sunset.

BULBS BELONG TO . . .

the Lily, Iris and Amaryllis families mainly, although a number are in other families too. The genus names listed under the following families are all mentioned in this "Handbook on Bulbs."

Lily Family (Liliaceae)

Agapanthus	Eremurus	Milla
Allium	Erythronium	Muscari
Anthericum	Fritillaria	Ornithogalum
Bowiea	Galtonia	Paradisea
Brodiaea	Gloriosa	Puschkinia
Bulbocodium	Hyacinthus	Scilla
Calochortus	Lachenalia	Tulipa
Camassia	Leucocoryne	Tulbaghia
Chionodoxa	Leucocrinum	Veltheimia
Colchicum	Lilium	

Iris Family (Iridaceae)

Acidanthera	Gladiolus	Sparaxis
Belamcanda	Iris	Tigridia
Crocus	Ixia	Watsonia
Freesia	Montbretia	

Amaryllis Family (Amaryllidaceae)

Alstroemeria	Galanthus	Narcissus
Amarcrinum	Haemanthus	Nerine
Amaryllis (also see Hippeastrum)	Hippeastrum (also see Amaryllis)	Polianthes
Chlidanthus	Hymenocallis (Ismene)	Sprekelia
Cooperia	Ixiolirion	Sternbergia
Crinum	Leucojum	Vallota
Eucharis	Lycoris	Zephyranthes

Arum Family (Araceae)

Amorphophallus
Caladium
Colocasia
Hydrosme
Zantedeschia

Gesneria Family (Gesneriaceae)

Achimenes
Sinningia (Gloxinia)

Begonia Family (Begoniaceae)

Begonia

Primrose Family (Primulaceae)

Cyclamen

Oxalis Family (Oxalidaceae)

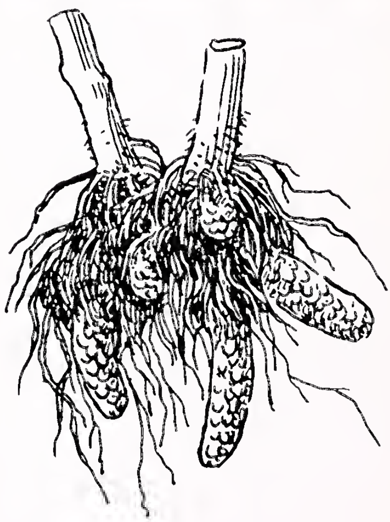
Oxalis

AN ILLUSTRATED DICTIONARY OF BULBS

Other than those covered on preceding pages

Achimenes 'Ambroise Verschaffelt' has 2-inch blossoms veined vivid purple over a light ground color. Cluster of tuberous roots at base of stems (below) is ¾ natural size

Genereux



Achimenes

Outstanding features: The velvety, tubular flowers which appear in summer, are flared open at the ends, and range in color from white through the pinks and reds to violet; also yellow, and some with pansy-like faces. These semi-tropical plants grow from 18 to 24 inches high, but some are drooping or trailing. They make excellent pot and basket plants.

Culture: In temperate climates achimenes must have indoor culture. Start the scaly rhizomes in a warm (never below 60°), humid place, in a sand-peat mixture, ½ to 1 inch deep, in late winter. Good drainage is essential. Keep soil barely moist, and in subdued light until growth starts, then increase water and give adequate light, with some shade during the hottest part of the day. When flowering ceases, gradually reduce water. Keep the dormant rhizomes cool and dry in winter (45-50°). Split up rhizomes when repotting.

Kinds: There are several good species and many named hybrids of achimenes, in all colors. Among these are *A. tubiflora* having pure white flowers 4 inches long; *A. grandiflora* with large, violet flowers; and *A. longiflora* having violet flowers with long tubes.

Acidanthera

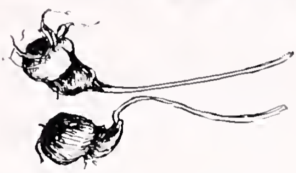
Outstanding features: The fragrant, delicate flowers bloom during summer. Plants, 1 to 4 feet high with flat, erect stems, like gladiolus.

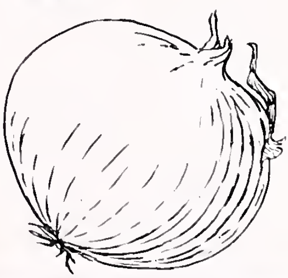
Culture: Grow in a cool greenhouse in sandy loam and "leaf soil". Water well during growth; keep dry during the resting season.

Outdoors, treat as gladiolus. Plant corms in spring in a sunny place in a loam soil lightened with plenty of coarse sand. Take up in the fall, before frost. Propagate by offsets.

Kinds: *Acidanthera bicolor*, the kind most generally grown; has white flowers with a triangular purple blotch at base. *A. murieliae* from Ethiopia seems more robust.

Sweet-scented acidanthera (above) grows like gladiolus; corms at left are ½ natural size





Chives, garlic, onion — *Allium*

Outstanding features: Many hardy garden forms particularly useful in rock garden. Foliage is tubular, either round or flattened, of varying length. Small flowers are borne in round heads; colors are white, lavender, rose, purple, also yellow.

Culture: Plant bulbs in spring in well-drained, sandy soil. Most species can be left for years in same spot. Cut seedheads before they shatter. Propagate by seed or bulbs as for onions.

Kinds: Commonest ornamental species are:

- *Allium angulosum*—light purple flowers in June, 12 in.
- *cernuum*—rose colored flowers in August, 24-30 in.
- *kansuense*—bright blue flowers in August, 6-8 in.
- *karataviense*—dull pink flowers in July, 6-8 in. prostrate foliage blue, purple-green in spring.
- *moly*—loose clusters of larger yellow flowers in June, 12-15 in.
- *schoenoprasum*. Chives. Round heads of rosy purple flowers, in June-July, 15-24 in.

Allium giganteum bears rose-tinted flower heads in early summer. Typical allium bulb (above) is 2/3 natural size

Alstroemeria

Outstanding features: Tuberous-rooted South American plants, which produce clusters of richly colored flowers on tall stems in late spring or early summer outdoors. Reliably hardy to Washington, D. C. or farther north in sheltered places where tubers should be planted as deep as 8 inches.

Culture: In the garden, plant in fall in sun or part shade in light soil 2 to 4 inches deep. Mulch for the winter. In the coldest areas, lift tubers from garden in fall and store for the winter. Good as pot plant in cool greenhouse.

Kinds: *A. aurantiaca,* 36 in., pure yellow, *chilensis,* 48 in., red, pink, orange or yellow, beautifully marked, *ligtu,* 24 in., rose-pink, *pelegrina,* 24 in., violet-pink; also in white.

Amorphophallus, see **Hydrosme**

Windflower ***Anemone***

Outstanding features: Flowers are about 2½ inches across, resembling buttercups, in brilliant reds, violets, purples and white. Plants 6 to 12 inches, with most of the leaves produced at the crown. Beautiful in the garden and good as cut flowers. Not hardy north of New York or Cleveland.

Culture: In milder districts, plant the tubers in late fall, so new growth will not start before winter. Plant 6 inches apart, 3 inches deep, in a deep, rich, sandy soil. Cover with airy mulch for the winter, and replace this with a 2-inch mulch of peat or humus in spring.

Easily raised from seed planted outdoors in summer, or started under glass in January or February. Until seed germinates (about 3 weeks) keep moist and shaded. Set young plants in full sun; keep them watered. In the North, after foliage dies down, take up tubers and store in a cool place in dry sand, as with dahlias.

Kinds: *Anemone coronaria,* poppy anemone, is the most commonly grown. In this group are St. Brigid anemones having semidouble and double flowers in many brilliant colors.

Genereux

Alstroemeria blooms (above) have extraordinary beauty. Tuberous roots at right are about ½ natural size

Anemone coronaria blossoms are like a bright bouquet in spring. Tubers below about ½ natural size

Genereux

A mature plant of Agapanthus

McFarland

African Lily — *Agapanthus*

Outstanding features: This half-hardy plant from South Africa has umbels of bright blue, funnel-shaped flowers borne on stems 2½ to 3 feet high in summer. The foliage is long and narrow. Agapanthus is not really a bulb since it has fleshy, bulbous roots.

Culture: Easy to grow in light soil enriched with plenty of well-decayed manure. Use a mixture of sandy loam and leaf soil made firm around the fleshy roots. Water heavily during the growing season. Late in the fall, withhold water, and store plants indoors in a frost-free place until spring. Keep the plants in pots for easy moving. In milder localities, leave them outdoors all winter, but protect them by covering the crowns with straw. Agapanthus also makes an excellent cool greenhouse plant.

It takes five or six years to raise flowering plants from seed. Propagate by dividing the plants in spring, when repotting.

Kinds: *Agapanthus umbellatus* (*A. africanus*) and its varieties are most popular. Variety *mooreanus* is more compact and has deep blue flowers smaller than the species. 'Von Weillighi' has lavender flowers edged with indigo.

Amaryllis, see **Hippeastrum**

Blackberry-Lily — *Belamcanda chinensis*

Outstanding features: Orange flowers spotted red followed by loose clusters of black seeds giving it the name of blackberry-lily. Useful in perennial border where hardy.

Culture: Easily grown from seeds or divisions in rich sandy soil and sunny location.

Kinds: Only one species.

Blackberry-lily blossoms are followed by berry-like seeds (above left). Rootstock (above right) is about ½ natural size

Begonia evansiana

Outstanding features: Two-foot plants produce light green leaves colored red beneath. Pink flowers on reddish stalks open in late summer. Valuable shade-loving plant, hardy except in far north where bulbils can be gathered in the fall, stored in a cool place for the winter and replanted the next spring.

Culture: Plant tubers or bulbils in spring in a soil rich in humus, in shade. Water when necessary to keep the soil moist. After frost has killed the tops, mulch with light, airy material. Clusters of tubers may be divided in spring.

Kinds: There is just the one species, native of China and Japan.

McFarland

Begonia evansiana in bloom

Brodiaea

Outstanding features: There are numerous species of this cormous plant, native to the West Coast, which have grass-like leaves growing at the base of the plant and slender, naked stems that carry the clusters of flowers.

Culture: The one strict requirement of brodiaeas is that they need well-drained soil. They should have plenty of moisture while growing and blooming in spring and early summer, and be completely dry in summer. In eastern U.S. gardens, such conditions may exist in rock gardens. Otherwise, dig the corms when the foliage ripens, store them dry for the summer, and replant 4 inches deep in October.

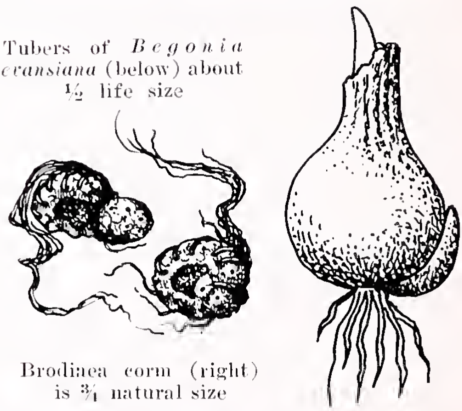
Kinds: There are some thirty species and a number of varieties, of which the following are best:

B. coccinea, called the floral firecracker, rich crimson, 24-30 in.

coronaria, June flowering, long-lasting deep blue flowers.

laxa, the triplet-lily, purple, 12 to 30 in., up to 50 flowers in a cluster.

Tubers of *Begonia evansiana* (below) about ½ life size



Brodiaea corm (right) is ¾ natural size

Brodiaea laxa flower cluster

Spring Meadow-Saffron
Bulbocodium

Outstanding features: Rosy purple flowers with white spots appear close to the ground, usually earlier than true crocus and with broader leaves.

Culture: Where hardy should be planted in fall and dug and separated every 2 to 3 years as with crocus.

Kinds: *B. vernum* is the commonest in gardens. *B. versicolor* is a smaller but very attractive form.

Blooms of bulbocodium are above; the corm at left is less than ½ natural size

Caladium tuber (below) is about ½ life size. Typical color mottling of caladium foliage is shown at bottom of page

Caladium

Outstanding features: Tropical tuberous plants, which are popular because the large leaves of the many available varieties are handsomely colored in green, red, pink, white in endless color combinations and patterns, through variegation and mottling. Though caladiums have blooms, they are not very decorative.

Culture: Being tender, tubers are started indoors or in a greenhouse in pots or boxes of moist peat moss or similar material. After roots start, pot in loose, rich soil. Plant into the garden, in a shady place, only when weather is warm. Keep caladiums watered. After fall frost, lift and store tubers in dry material in warm place.

Kinds: Fancy-leaf caladiums are available as named varieties, or by color.

Calla, see **Zantedeschia**

Elephant-ear, below, often classed as *Caladium esculentum*, belongs to the genus *Colocasia*
McFarland

Mariposa-Lily, Star-Tulip, Globe-Tulip *Calochortus*

Outstanding features: Calochortus have showy flowers and grow 9 to 24 inches tall, with narrow leaves. Flowers appear in summer.

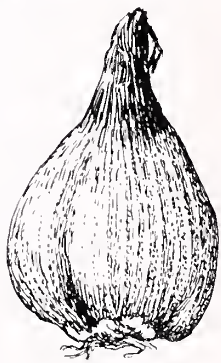
Culture: Plant corms in mid- to late fall, 2 to 3 inches deep in a light, porous soil with perfect drainage. Globe-tulips (*C. albus*) do best in soil with ample organic matter, and in partial shade. Mariposa-lilies (*C. luteus, splendens, venustus*) prefer full sun and a slightly heavier soil. Keep the bulbs as dry as possible during the winter and protect them then with a thick mulch. Remove the covering in early spring. Water amply during the growing season. After flowering and the foliage has "ripened," lift the bulbs and store in a dry place until planting time. Or, leave them in the ground if it is well-drained. They will not have to be lifted for three years, except to separate them to increase the stock.

Indoors, calochortus may be treated as hardy forced bulbs (see earlier articles).

Propagate by offsets or seeds.

Kinds: Popular calochortus are *C. albus* with roundish, drooping flowers, pearly white with a deep blotch at base of petals; *C. luteus* with cup-shaped flowers in July, from light yellow to orange, inner petals tinged reddish brown at base; *C. splendens*, large pale lilac flowers in August, inner petals blotched deep purple at base; *C. venustus* with large, white, cup-shaped flowers, inner petals yellow, stained crimson.

Blooms of *Calochortus albus* are above; corm at left below is ½ life size



Blooms below are *Camassia quamash;* bulb of *C. cusicki* (above right) is ½ life size

Camass *Camassia*

Outstanding features: Hardy, North American bulbs, bearing spikes of blue, starry flowers in spring. Plant in fall, selecting place where soil is moist in the springtime.

Kinds: *C. cusicki*, 30 in., pale blue; *leichtlini*, 2 ft., bright blue; *quamash*, 30 in., dark blue.

Chlidanthus

Outstanding features: This tropical American bulb has narrow basal leaves and fragrant, yellow, tubular flowers in summer. A good rock garden plant.

Culture: Hardy only in the South where bulbs should be planted 3 inches deep, and treated like a perennial flower. In the North, grow as a potted plant, using a soil mixture containing much humus. In fall, when foliage dies down, store the bulbs dry for the winter in 40 to 50°F. temperature. Bulbs may also be potted in April, plunged to the rim in the garden for the summer, and lifted and dried in fall.

Kinds: *C. fragrans,* 10. in., yellow.

Rain-Lily, Prairie-Lily *Cooperia*

Outstanding features: This summer-flowering bulb, native in Texas and Mexico, is hardy north to the mid-Atlantic states where naturalized clumps of the low-growing, star-like flowers make fragrant clumps.

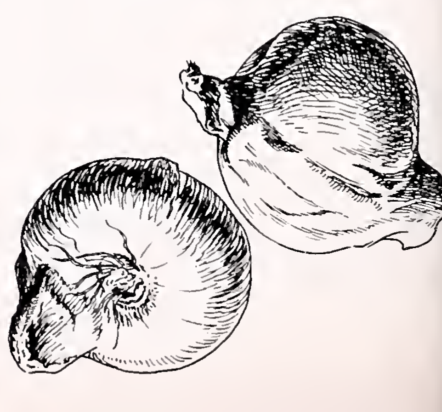
Culture: In gardens, plant bulbs 2 inches deep in well-drained soil in a sunny location in spring. Potted bulbs, forced at a 50°F. temperature, need not be repotted until bulbs become crowded.

Kinds: *C. drummondi,* 8 to 10 in., white with red tinting; *C. pedunculata,* 4 to 8 in., white, red tinting.

Chlidanthus bulbs

The fragrant, yellow flowers of chlidanthus (top of page) are about 4 inches long. Bulbs of *C. fragrans* (far left) are ½ natural size. Blooms and seed pods of *Cooperia drummondi* are below left. Cooperia bulb (left) is ¾ life size

Colchicum corms, when purchased in early autumn, have flower buds fully formed—see bulge under husk—ready to bloom. Corms below are ½ life size. For article on colchicums, see page 58



Most kinds of crinums have broader-petalled flowers than *C. asiaticum* at right. Narrow petals and dark colored filaments are distinguishing characteristics of this species

Crinum bulbs are usually planted with only the rounded, bulbous part below ground level. Bulb at lower right is ½ natural size

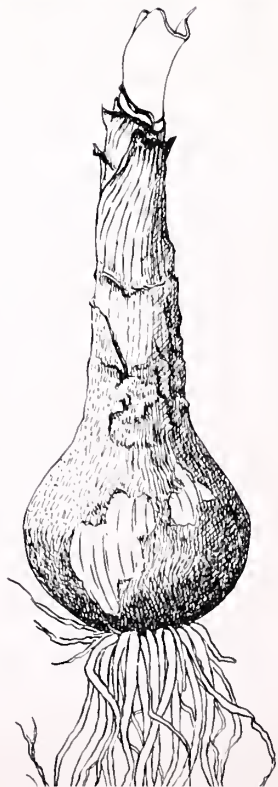
Genereux photo

Crinum

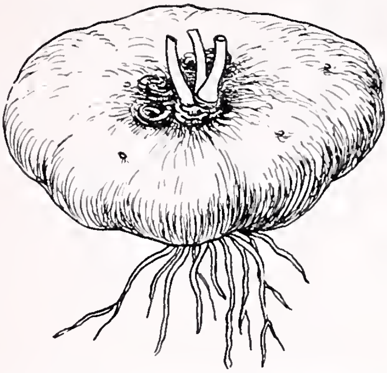
Outstanding features: Tropical and semi-tropical bulbs, mostly evergreen, with large-size bulbs. Popular garden plants in the South; grown as large pot or tub plant in the North. The flower stalks, often 2 to 4 ft. high, are topped with clusters of long-tubed, often fragrant flowers, mostly in late summer.

Culture: From Washington, D. C. south, plant outdoors in spring in rich, humusy soil, setting the bulb only half below soil level, except at northern limit of hardiness where it should go in at soil level and be well mulched for winter. Bulbs may also be planted in gardens for summer bloom and dug and potted for winter storage in semi-dormant condition. Grown as pot plant, feed when blooms are developing, and rest for awhile in winter.

Kinds: Southern swamp lily, *C. americanum,* pure white — needs wet soil; *C. longifolium,* white or pink; 'Cecil Houdyshel,' rose-pink, tall; 'Ellen Bosanquet,' deep wine-rose; *C. asiaticum,* white, fragrant, with narrow petals.



A charming clump of *Cyclamen neopolitanum* (above) and its corm below (½ natural size).



Eremurus (below) is a dramatic, summer-flowering plant. The thick roots (lower right) are shown 2/5 life size

Cyclamen

Outstanding features: Several species are hardy and will grow well outdoors, producing charming flowers, much smaller than the florist type, in fall or spring, on plants growing about 4 inches high.

Culture: Use gritty, non-acid soil. Plant in shade, setting the corm so that it is at soil level. Good also as pot plant in a cool greenhouse.

Kinds: *C. atkinsi,* pink or white, spring-flowering

coum, bright crimson, spring-flowering

europaeum, crimson, sweet-scented, fall-blooming

neapolitanum, rosy-pink or white, foliage silvery marbled, fall-blooming

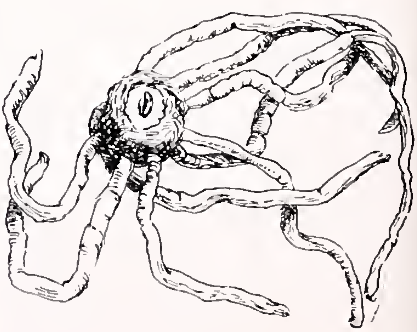
repandum, bright crimson, spring-flowering.

Foxtail-Lily ***Eremurus***

Outstanding features: Tall spikes of bell-like flowers carried on a 3- to 6-foot stem arising from a rosette of sword-like leaves. Good accent plant in a perennial border.

Culture: Plant fleshy roots in September and leave for years in same position. Where snow coverage is light, mulch with leaves or straw. Average garden soil with good drainage suits them well.

Kinds: *E. bungei* has yellow flowers borne on 3- to 4-foot spike in July. *E. elwesi* has pink flowers in June on taller stem. *E. himalaicus* has white flowers in June and grows to 6 ft., while *E. robustus* has pink flowers in June and is the tallest of all.



E. tuolumnense has light green leaves

Grossman

Leaves of *E. revolutum johnsoni* are mottled

Trout-Lily, Dogs-Tooth Violet

Erythronium

Outstanding features: Several species native in western U. S. which do not adapt themselves well to eastern conditions. Most have attractively mottled, bright green, twin basal leaves with a slender spathe carrying usually one, sometimes a few, nodding lily-like flowers with reflexed segments. Colors yellow, white and pink.

Culture: Eastern species grow in moist woodsy soil in part shade. They should be left to naturalize in a wild garden or shaded border where they propagate by underground stolons forming offset bulbs. Western species propagate readily from seed. They are more at home at higher altitudes or in rock gardens.

Kinds: There are several species and forms native to Europe and N. America. The commonest is the eastern dogs-tooth violet, *E. americanum,* with mottled leaves and solitary yellow flowers; grows from Canada to Florida. The other two easterners are *E. albidum* with white flowers and *E. propullans* with rose-tipped flowers, neither of which has mottled leaves.

On the West Coast, *E. grandiflorum* grows from almost sea level to high altitudes and there are consequently many variant forms. *E. revolutum* varies from white to pink and also has several named forms.

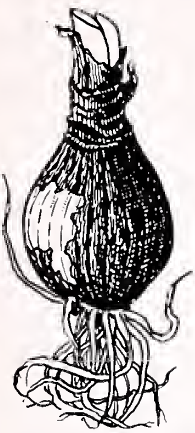
Bulb of *Erythronium americanum* shown about natural size

Amazon-Lily *Eucharis*

Outstanding features: Tropical bulbs with evergreen foliage, producing one or more crops of fragrant flowers each year.

Culture: Best grown in a greenhouse having 55°F. minimum night temperature. Use 8-inch or larger pot and a rich, humusy soil. Keep shaded, and the humidity high. Repot every two or three years.

Kinds: *E. grandiflora* (*E. amazonica*), to 2 ft., white.



Eucharis (above) makes an elegant plant which remains in leaf the year around. Its blooms are gracefully placed. Bulb (left) is ½ natural size

Snowdrop *Galanthus*

Outstanding features: This plant is extremely hardy, despite its fragile appearance. Its nodding white flowers generally appear before winter is over. It grows 6 to 12 inches high. Charming when planted in masses under evergreen or deciduous trees, or even in lawns where early summer mowing can be omitted. Plant in dozens for good effect.

Culture: Plant bulbs in early autumn in medium to heavy soil, in a moist, cool, shady situation. Cover the bulbs two or three times their depth. Once planted they can be left for years. They thrive if given a top-dressing of well-rotted manure each autumn. As with other bulbous plants, do not cut off the leaves; they should ripen thoroughly, and disappear naturally.

Snowdrops propagate themselves slowly by self-seeding.

Kinds: There are several good species and varieties. Most popular are *G. nivalis*, the common snowdrop; *G. elwesi* and its varieties that have larger flowers; and *G. plicatus* which blooms later than the others.

A close-up study of *Galanthus nivalis* blossoms (far left) reveals green markings on inner petals. Bulbs at left are ½ natural size

Checkered-lily, a common name for *Fritillaria meleagris*, is obviously appropriate

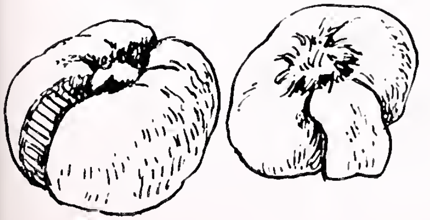
The flowers under top tuft of leaves on crown imperial (*F. imperialis*) have an odor

Fritillary ***Fritillaria***

Outstanding features: Many varying species, a few of which are useful in perennial borders, rock gardens or naturalized in wild gardens. Most have nodding bell-like flowers.

Culture: Bulbs are planted in early fall and mulched. Most of them prefer moist light soil with partial shade. *F. imperialis* likes rich garden loam and *F. meleagris* does well in a moist but well-drained site. They all prefer to be left alone and will gradually increase by offsets.

Kinds: *F. imperialis*, the crown imperial, has a stout leafy stem to 3 ft. surmounted by a whorl of drooping, reflexed, lily-like flowers in orange-pink or red. Their odor is disagreeable and the season of bloom later than the others. *F. meleagris*, the guinea-hen-flower, has solitary, drooping, brown and purple mottled flowers on 12-inch stems; there is an attractive white form. *F. pudica* and *F. pallidiflora* both have yellow flowers, are low growing, and more suitable for the rock garden.



Bulbs of *F. meleagris* (left) are natural size

Giant Summer-Hyacinth ***Galtonia***

Outstanding features: Tall, summer-flowering. This South African bulb bears white, bell-like blossoms along the upper half of the stalk which rises above the long, narrow basal leaves.

Culture: Plant the bulbs 3 to 5 inches deep after the soil becomes warm in spring. In dry weather, water frequently to keep soil moist. Dig, dry, and store at 55° to 60°F. for the winter, except in mid-South where bulbs are hardy when mulched. Not satisfactory in far South.

Kinds: *G. candicans*, 3 to 4 ft., white.

A cluster of galtonia bulbs (above) makes a fine display of white flowers in summer. Galtonia bulb left is ½ natural size

Glory-Lily ***Gloriosa***

Outstanding features: Brightly colored, lily-like flowers are mostly borne in summer, on climbing plants which average 3 to 6 feet high in the garden or greenhouse. Petals of the 4-inch blooms are red banded with yellow, wavy edges. The plants climb by means of leaf-tip tendrils.

Culture: For early bloom outdoors, start the tuberous roots in pots indoors using a light soil mixture. Plant out of pots 4 inches deep when weather is warm. Supply a light support for vines. In fall, lift carefully, because roots are brittle, and store in a warm place for winter. Indoors, grow in a 65° temperature. Keep well watered while growth is active. When plants go dormant in late fall, dry for two months, then repot tubers and start into growth again.

Kinds: *G. virescens* (*planti*), rather dwarf, orange

rothschildiana, brilliant red and orange

superba, like the above, but petals much frilled.

Genereux

Gloriosa blooms are of special value for cutting and making corsages. Tuberous roots (left) are shown about ⅓ natural size

Gloxinia ***Sinningia***

Outstanding features: Bell-like blossoms, up to 4 inches across, are borne continuously in spring and summer on short stems above large velvety leaves. The flowers are usually solid colored, or two-toned, in violet, purple, rose, maroon, white.

Culture: Gloxinias may be grown from young potted plants, started from leaf cuttings, or dormant tubers. Potting soil for gloxinias should be coarse, rich, fibrous. Tubers potted in November will bloom by spring. After growth slackens in late summer, rest the tubers in their pots and start into growth again in winter. Keep gloxinias out of sun in summer. Avoid wetting the leaves.

Kinds: Gloxinias are available as named varieties, such as 'Fire King' (carmine) and 'Emperor William' (blue and white); as strains, such as Buell's hybrids; and by type including the "slippers"—long, tubular flowered.

The coloring of some recently introduced gloxinias is stippled instead of solid. Gloxinia tuber below is life size

Blood- Lily ***Haemanthus***

Outstanding features: This South African bulb is grown as a pot plant. Blooms in spring, summer or fall. Typical flower head is globular cluster of star-like flowers on thick flower stalk.

Culture: Use rich loamy soil mix, and grow in light shade. Water freely during the growing season; keep dry while dormant in winter except the evergreen species. Bulbs may be kept outdoors, even when dormant, in summer.

Kinds: *H. coccineus,* 12 to 24 in., blood-red flowers followed by purple berries.
katherinae, 12 to 24 in., scarlet.

McFarland

Haemanthus in bloom is rather bizarre-looking since the brilliant flower cluster often overshadows the sparse, unimpressive foliage. Bulb (right) is ½ life size

One common name of hydrosme is devils-tongue, suggested by the long dark spadix extending above the dark, calla-like spathe; (see above); another is snake-palm, a name suggested by the oddly mottled, big palm-like leaf. Planting-size tuber at left is ½ natural size

Devils-Tongue ***Hydrosme***

Outstanding features: The dark-colored calla-like flower, often foul smelling, is borne by the tuberous roots in late winter or spring before a large, much-divided, umbrella-like leaf forms. Flowers last only a few days, but the leaf lasts all summer. Grown principally as a curiosity, as a tender pot or tub plant.

Culture: Plant tuber in a large pot or tub. After blooming indoors, set outdoors for the summer, or plant in the garden. Store in a cool place, while dormant, for the winter.

Kinds: *H.* (*Amorphophallus*) *rivieri,* to 4 ft.

Peruvian Daffodil
Hymenocallis (Ismene)

Outstanding features: Tender, summer-flowering bulbs of rapid growth. Dark green, strap-like, attractive foliage resembles that of amaryllis. The large, white, spidery flowers have long tubular crowns surrounded by narrow, reflexed perianth segments which are borne very soon after planting.

Culture: Much like gladiolus. Plant bulbs 3 to 4 inches deep in rich, well-drained soil in full sunshine, after the earth is thoroughly warmed. Dig before frost and store upside down in vermiculite at 50° to 60°F. Do not remove roots.

Kinds: The most popular species is *H. calathina,* the common ismene. *Festalis* is a variety with spidery appearance due to the very narrow curved perianth segments. 'Sulphur Green' is a pale yellow hybrid.

The sweetly-scented, exotically formed flowers of *Hymenocallis calathina* (far left) develop within three weeks after planting. Bulb at left is ½ life size

Amaryllis ***Hippaestrum***

Outstanding features: Easily grown tender bulbs for indoors. Some species suitable for garden culture in South. Narrow or strap-shaped leaves and hollow scape (stem) rise from a large bulb. There are two to four large funnel-shaped flowers borne in an umbel. The colors vary from yellowish and greenish white through orange and pink to red. In some species the flowers precede the leaves but in most popular sorts the leaves come first.

Culture: Bulbs are potted in autumn or early winter. Use one part garden loam, one part leaf mold or peat and one part sand with a 4-inch potful of balanced fertilizer per bushel. Pots should appear a bit too small for such large bulbs as plants that are crowded have better blooms. Leave almost half of the bulb above the surface of the soil, water sparingly and place in subdued light under greenhouse or cool room. When growth starts, increase water and stand in full sunlight and warmth. As soon as the flower scape appears, start feeding each week with manure water or liquid fertilizer until bloom buds show color. After bloom, cut off scape for the summer, plunge the pot in the garden and keep the bulb growing. In the fall, bring the bulbs inside. Reduce water until leaves dry. Place pot on side in cool place to rest. In evergreen species water sparingly. Repot only when necessary, disturbing the roots as little as possible. The best way to remove the spent soil is by dipping the root ball in a pail of water. New soil should be worked through the roots firmly with fingers.

Kinds: Most amaryllis grown today are hybrids. Some of the evergreen forms will bloom twice a year. Most people obtain bulbs of a strain such as Royal Dutch or Giants of California. Named kinds which come true to color are available. They are fairly expensive but since the bulbs last several years they are worth the investment.

The bulb popularly known as amaryllis is a hybrid form of hippeastrum. Bulb below is ½ life size.

Dutch iris (above left) clustered next to a tree peony. *Iris reticulata* does well in rock garden (above right)

Bulbs of English iris (left). *I. reticulata* bulbs (right) are covered with netted skin.

Iris

Spanish, English, Dutch, and Species Iris

Outstanding features: Bulbous iris are generally not hardy in the North. The different groups vary in appearance but have the common features of grassy or swordlike foliage and "flag" flowers in white, yellow, or violet and blue characteristic of the family.

Culture: Where hardy, Juno iris and reticulatas are left in the rock garden or perennial border for years where they bloom each spring. They prefer light, well-drained soil in full sunshine. Mulch in late fall to hold the snow.

Spanish and English iris, and the Dutch which are hybrids of these with other species, are usually grown as florist's flowers indoors, and treated much as are the hardy forced bulbs.

In milder climates they may be grown in the garden. The Spanish (*I. xiphium*) require light soil, good drainage, full sun and shelter from wind. The English (*I. xiphioides*) need summer moisture and rich soil. For best results they should be dug up after blooming in early summer and stored dry until fall, though they may be left in the ground for several years.

Kinds: Juno iris are not widely grown; the most common species are:

I. bucharica—which has yellow standards and golden falls, 24 in.

persica—violet, green, or golden flowers, 6 to 8 in.

rosenbachiana — varying from white and pink to gold with very large flowers for height of plant.

sindjarensis—blue and white, 10 to 12 in.

There are now different color forms of *I. reticulata* in blue and violet-purple.

There are also a large number of named varieties of the Spanish, English and Dutch hybrid iris. Some of the best are:

I. xiphium: 'King of the Blues,' 'Cajanus,' 'Thunderbolt,' 'British Queen.'

I. xiphioides: 'Lucinda,' 'Mont Blanc,' 'Othello,' 'Ruby.'

orn-Lily *Ixia*

Outstanding features: South African rms which bear brightly colored flowers tones of orange, blue, yellow, red and nk, often with contrasting eye, on wiry ems in spring.

Culture: Hardy in southern gardens here corms are planted 3 inches deep in ll, and mulched for winter where there e frosts. Best planted in clumps. Indoors, e forcing is as for freesias; bring pots in-ors before frost and keep at 55°.

Kinds: Available mostly in mixed colors, separate colors as named varieties.

Ixias carry their flowers on tall, wiry stems well above the grass-like foliage

Corm of ixia (right) is shown ½ natural size

xiolirion

Outstanding features: Blue, spring-looming Asiatic hardy bulbs, which need ood drainage, and so are best grown in the ock garden. Rarely seen in gardens.

Culture: Plant bulbs 3 in. deep in fall in nny location. Cover with light mulch for inter. Suitable also for forcing in cool reenhouse as for freesias.

Kinds: *I. montanum* (*I. ledebouri*), 12 ., lilac-blue.

he starry flowers f ixiolirion (far ight) are some-imes called Siber-n bluebells. Its ulbs (right) are ¾ natural size

McFarland

Clusters of the deep blue flowers of leucocoryne (above). Bulbs below natural size

Leucocoryne

Outstanding features: A sweet-scent spring-flowering Chilean bulb, hardy in t South, where it may be grown in bord and rock gardens.

Culture: In the South, plant in the fall well-drained soil. In pots, plant closely a care for bulbs as for freesias.

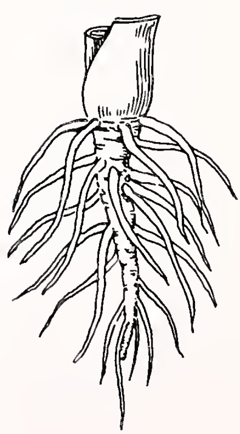
Kinds: *L. ixioides,* 18 in., flowers blue w white centers.

Sand-Lily, Star-Lily *Leucocrinu*

Outstanding features: A native, rhizom tous plant from western North Ameri which bears pure white, fragrant flowe in spring in such a way that they appear be coming out of the ground.

Culture: Plant 3 in. deep in fall in sunny, well-drained place, such as the ro garden.

Kinds: *L. montanum*, 4 in. high, white.



Blooms of leuc crinum (far lef are stemless, ar ing directly fr the base of t plant. Root (lef is ½ life size

McFarland

Because the 2-foot flower stalks of *Lycoris squamigera* (above left) suddenly come up and bloom, without leaves, in late summer, this bulb is sometimes called the ''magic lily.''

Lycoris radiata (above right) is also known as *Nerine sarniensis.* Because of the long stamens, one of its popular names is spider lily. Bulbs shown $\frac{3}{4}$ life size

coris

)utstanding features: Asiatic, late sum- and fall blooming bulbs. Their long, row leaves appear in spring, then soon en and die down; the flower stalks, ped with a cluster of pink or red flowers, leafless. One species, *L. squamigera,* is dy in the North; the rest are hardy stly below Washington, D. C.

:ulture: Plant bulbs 4 to 6 in. deep in it, fertile soil in late summer or fall. ive undisturbed in the garden from one r to the next. *L. radiata* and other species, grown as pot plants, are set in pots in late summer with top of bulb exposed, watered and fed while in active growth and bloom, and kept dry while resting in summer. Flowers best when crowded in pot.

Kinds: *L. radiata* (the Guernsey lily) to 18 in., bright red

aurea, to 2 ft., bright yellow in fall

sanguinea, to 18 in., red

squamigera (*Amaryllis halli*), the "hardy amaryllis," 24 in., lavender-pink, late summer.

Genereux

Milla biflora (above) has star-like, waxen white flowers borne on slender stems. Narrow leaves are basal. Bulbs (left) are ½ natural size

McFarland

Mexican Star ***Milla***

Outstanding features: This native of southwestern United States bears fragrant white flowers in spring. Hardy only in the South.

Culture: In the South, plant in flower borders in fall for early spring bloom. Indoors, put several bulbs in a pot, and force in a cool place. Water well while in growth; keep dry when dormant.

Kinds: *Milla biflora,* 12 to 18 in., white. *Milla uniflora* is a brodiaea.

Montbretia ***Tritonia***

Outstanding features: The flowers range in color from yellow through orange and red to copper and are borne on gracefully arching stems from 1 to 3 ft. tall. The season of bloom varies with the district depending on the method of culture. The leaves are narrow and sword-shaped, resembling gladiolus.

Culture: Tritonias are not reliably winter hardy. In warm temperate climates they will come through the winter outdoors, but in the North they must be lifted before frost and stored indoors like gladiolus.

They can be grown in warm sunny borders or in coldframes or greenhouses for cutting. Moisture is essential during growth but the drainage must be adequate.

Kinds: Among the best of many species are *T. crocata* with double-ranked spikes of yellow-orange, bell-shaped flowers, *T. crocosmaeflora* with scarlet, funnel-form flowers on branched stems and *T. pottsi* which also has spikes of yellow flowers. Usually offered by bulb dealers in mixed colors or named varieties.

Montbretias grow like gladiolus, but the flowers are much smaller and the flower stems branch. Corms (left) are ½ natural size

Nerine

Outstanding features: Brilliantly colored clusters of flowers are borne on strong stems in autumn, often when there are no leaves on the plants. Hardy only in the South; an excellent cool greenhouse plant.

Culture: Pot in fertile soil. Keep plants well watered and frequently fed during growing season from October to May, and dry during summer resting period. To rest, tip pots on side, and keep in sunny coldframe.

Kinds: *N. bowdeni*, 18 in., pink
curvifolia fothergilli, scarlet
undulata, tall, rose
Hybrids are also available.

Nerines flower best when left in the same container for several years and top dressed with enriched compost each fall. Bulb at right is about ½ natural size. To keep bulbs from crowding in pot, side bulblets, shown at base of bulb, can be removed

Star-of-Bethlehem *Ornithogalum*

Outstanding features: There are two distinct sorts. The first group consists of hardy, spring-flowering bulbs with green-margined, white, star-shaped flowers and grassy leaves. The second group of tender species, known as chincherinchees, carry their flowers in spikes or racemes.

Culture: The hardy forms grow in any average garden soil in either sun or part shade. They seed themselves so freely as to become a bad pest if allowed to do so. Can be left alone for years.

The tender forms can be grown indoors as freesias or planted in the garden each summer, grown as gladiolus, and stored over winter in vermiculite.

Kinds: Hardy—*O. umbellatum* is the commonest form, 6 to 12 in. tall.
pyramidale and *nutans* grow to 24 in.
Tender kinds: *arabicum*, racemes of white flowers with black pistils
caudatum, white flowers, green centers
thyrsoides aureum has yellow flowers.

The common hardy Star-of-Bethlehem is pictured below, growing at base of phlox clump. Bulbs (right) are ½ life size

Genereux

Oxalis bloom profusely and make fine pot plants with their clover-like leaves. Bulbs below are ¾ life size

McFarland

Oxalis

Outstanding features: Numerous bulbous kinds are excellent as house plants to grow in pots or hanging baskets, and as border flowers in mild climates.

Culture: Outdoors in the South, plant 2 in. deep in front part of a border, or use as edging for walks. Indoors, pot in fall in porous soil mixture. After growth starts, keep pot in full sun, water well. When flowering period ends, let pots dry, and store until autumn.

Kinds: *Oxalis bowieana,* large pink flowers; *cernua* (Bermuda buttercup), yellow; 'Grand Duchess,' large-flowered, winter-blooming, in white, pink and lavender.

St. Bruno-Lily *Paradisea*

Outstanding features: White fragrant flowers in racemes like small, rather uneven trumpet lilies. Hardy plant of alpine origin for outdoor use south of New York.

Culture: Good drainage and sunshine *necessary.* North of New York, it can be planted outdoors in spring, will bloom in mid-summer, and must be dug before frost. Store indoors in vermiculite. Propagation is by division of the stolons.

Kinds: One species having fleshy rhizomes and long narrow leaves, *Paradisea liliastrum,* to 2 ft., flowers funnel-shaped, 2 in. long.

Paradisea is frequently referred to botanically as *Anthericum liliastrum.* Several stalks of blooms are pictured at far left.. Rhizomes (left) are ½ natural size

Tuberose ***Polianthes***

Outstanding features: Tender, with spikes of very fragrant, waxy, white flowers on stalks 3 ft. in height. Excellent as a garden flower to be seen at a fair distance, but the fragrance is too strong for indoor use. Leaves long, narrow, red near base. Blooms in late summer or autumn.

Culture: Plant in garden when danger of frost is past in well-drained, though moist, rich soil. In North, they should be sprouted indoors like cannas, placing tubers in moist sphagnum moss in flats about May first. Dig before ground freezes and store in dry warm spot at 50 to 60°F. over winter.

Kinds: One species, *Polianthes tuberosa.* The double form, called 'Pearl,' is the one usually planted.

Roche

The single-flowered tuberose, above, is more graceful but less popular than the double-flowered form. Bulb at right is ½ natural size

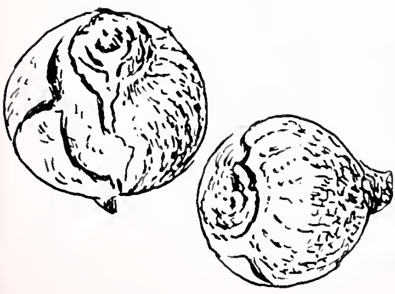
Lebanon Squill ***Puschkinia***

Outstanding features: A hardy, spring-flowering bulb from Asia Minor, the flowers of which resemble the scilla, and are pale blue. Recommended for rock gardens.

Culture: Plant in the fall, as for scillas.

Kinds: *Puschkinia scilloides* var. *libanotica,* 6 in., blue. Available also in a pure white variety.

Puschkinias (below) so closely resemble scillas in form, habit of growth and color as to be easily mistaken for them. Bulbs at left are life size



Florist's Ranunculus *Ranunculus*

Outstanding features: "Buttercup" flowers 1 to 4 in. across in many bright colors, white, yellow, orange, crimson and pink, both double and single. Stems 12 to 18 in. high.

Culture: As for florist's anemone, either for cut flowers in a cool greenhouse or for garden use. Not hardy in the North.

Propagation by seed or division of tubers.

Kinds: There are various strains, such as French, Persian, Peony-flowered and Turban. One with largest flowers is called 'Tecolote Giant.'

Ranunculus flowers look like giant, double buttercups. Tuberous roots below are ¾ life size

Wand-Flower *Sparaxis*

Outstanding features: South African corms that grow like ixias, but have larger blooms in brilliant tones of yellow, red, lavender, white and combinations of these colors. Spring-flowering. Not hardy in the North.

Culture: Suitable as a rock garden plant in mild climates where corms may be planted in fall. In the North, grow in pots, treating them like freesias or ixias, forcing into bloom in a cool greenhouse.

Kinds: Available principally in mixed colors, growing to 12 inches.

Blossoms of sparaxis (lower left) are often strongly pencilled with contrasting color. Corms below are ¾ natural size

Aztec- or Jacobean-Lily ***Sprekelia***

Outstanding features: Tender Mexican bulb useful in southern gardens or northern greenhouses. Solitary 3 to 4 in. flowers on $1\frac{1}{2}$ ft. stems are bright red and the narrow segments have spidery appearance.

Culture: Propagation by offsets. Indoor culture as for hippeastrum. Sometimes grown as summer-flowering bulb outdoors in northern gardens but handled this way it is often temperamental.

Kinds: Only one species, *S. formosissima,* often called *Amaryllis formosissima.*

Roche

Sprekelia (above) grows like an amaryllis, but the flower petals are narrow. Several bulbs may be grown in one pot, and repotting is unnecessary for two or more years. Bulb at right is ½ size

Mexican Tiger-Flower ***Tigridia***

Outstanding features: Stem and leaves similar to, but smaller than, gladiolus. Flowers facing upwards have central spotted cup made up of six small segments. Perianth of three much larger segments gives triangular appearance. Colors vary from buff and yellow to deep reds. Flowers last only a day but more keep coming.

Culture: Treated like gladiolus, but the bulbs prefer well-drained sandy soil. Grow in sun or part shade. Hardy enough to remain in the ground over winter at New York.

Kinds: There are a few named varieties of *T. pavonia,* which grows 12 to 24 in. high, but mixtures are most popular.

Tritonia see **Montbretia**

Tigridia (right) is most effective when grown as a clump in the garden. From time to time, plant breeders have produced many novel color combinations in this flower, and many more are possible. Tigridia bulb at right is 2/3 natural size

McFarland

Armstrong Nurseries

Under ideal growing conditions, tulbaghia (above) will make a thick clump 3 feet across in the garden. Northern gardeners may grow it in a cool greenhouse. Corms (left) are about ½ life size

Vallota (below) responds wonderfully well to frequent feeding as buds and blooms form. Bulb (below) is ½ life size

Tulbaghia

Outstanding features: Clusters of small tubular flowers, resembling those of agapanthus, are borne in abundance over a long blooming period, particularly in California and other mild climates. Makes a good house plant.

Culture: Plant in porous soil in full sun. Foliage is evergreen but cannot endure a temperature lower than 25°. Where winters are severe, lift clumps in autumn and store over winter. Treated like agapanthus as a pot plant, this bulb is nearly ever-blooming. Avoid over-watering.

Kinds: *T. fragrans,* 18 in., pink, flowers very fragrant, foliage odorless, winter-blooming when grown as a pot plant.

violacea (society garlic), 18 in., rosy violet not a good house plant since foliage has onion odor.

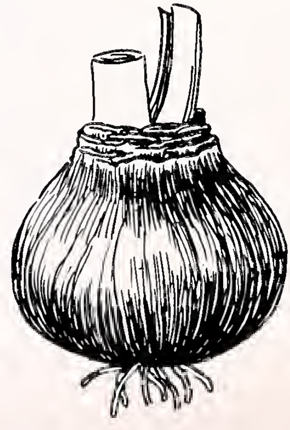
'Silver Lace', leaves blue-green edged white.

Scarborough-Lily *Vallota*

Outstanding features: Lush, amaryllis like foliage and umbels of scarlet flowers on 2- to 3-foot stalks make this bulb most colorful in southern gardens or when grown as a large pot or tub plant indoors or in the greenhouse in sun or light shade.

Culture: Keep the bulbs well fed and watered during spring and summer through the flowering period which is late summer and autumn. During balance of year, apply less water but never let bulbs get dry. Repot only every few years because bulbs bloom best when crowded.

Kinds: *V. speciosa,* scarlet, and var. *alba* white

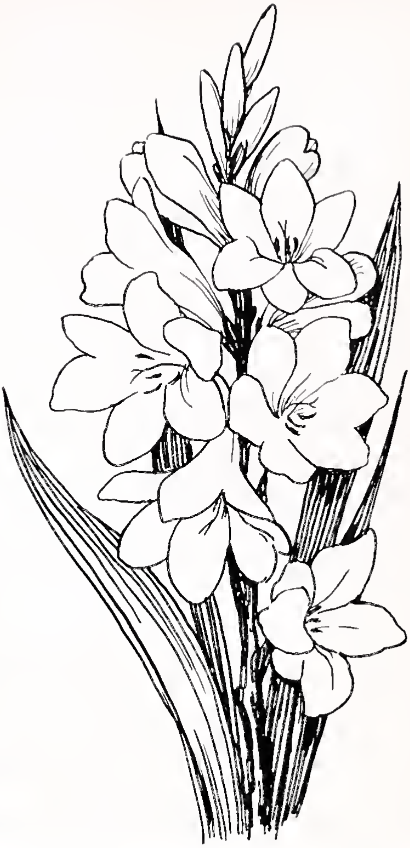


atsonia

Outstanding features: This South African .lb, a close relative of the gladiolus, is ost successfully grown in West Coast and uthern gardens. Tall spikes of brightly lored flowers are borne in spring, on most ailable varieties.

Culture: Watsonias look like small-flowed gladiolus, and are grown like them cept that they are fall-planted in mild imates, and since they grow in winter, ust be protected from frost. Plant in full n, and water while in growth; keep dry hile dormant. Give evergreen varieties ough water to retain the foliage. Watsons may be grown in pots in a cool greenuse.

Kinds: Available mostly in mixed colors, named varieties in pink, lilac, flameange, orchid, white.



he close resemblance watsonia blooms to adiolus is apparent in e sketch (above right). rms above 3/4 life size

nce watsonias make ll, slender growth, ey are more effective hen planted in large groups, as at right

McFarland

This sort of planting of the golden calla (*Z. elliottiana*) and fancy-leaved caladiums, is particularly suited to mild-climate gardens

Roche

Calla *Zantedeschi*

Outstanding features: There are severa species, all desirable, having large elegan foliage and waxen flowers colored whit yellow or pink. Not hardy in the North, bu nevertheless not difficult to grow there as pool-side plant.

Culture: In the South, plant in partl shaded place in rich, humusy soil, 4 in. dee Water and feed well during growing seaso especially *Z. aethiopica* and its variety *gode freyana*. For outdoor culture in the Nort start early indoors and plant in rich soil i the garden when the weather is warm. A a pot plant, grow in large pot barely cove ing the rhizome with soil, leaving space a top for top-dressing with prepared manur later. After growth starts, water freely, fee often. In fall, dry and store for the winte

Kinds: *Z. aethiopica* (common calla), t 3 ft. white; var. *godefreyana*, smaller-flowere

albo-maculata (spotted calla), 18 in., whit flowers with purple throat inside, leave heavily spotted silvery white

elliottiana (golden calla), medium-size yel low blooms, spotted foliage

rehmanni (pink calla), narrow leave flowers various shades of lavender-pin plant miniature.

The form and beauty of flower and leaf of golden calla is dramatized in illustration at left. Rhizome of *Z. rehmanni* below is 2/3 natural size

'ephyr-Lily *Zephyranthes*

Outstanding features: Flowering bulb of iry grace. Basal foliage grass-like; dainty, olitary, funnel-form flowers borne on slenler stems. Native to South America with me species in Southern U. S.

Culture: North of Washington they must e grown as pot plants, or as summer-flowring bulbs outdoors. Plant 2 in. deep and ! in. apart in light soil in sun. Dig before rost and store as gladiolus.

Indoors, plant half a dozen in a 5-inch ot of light fibrous soil. Keep moist while rowing and during bloom. Reduce water fter bloom and give 8 to 10 weeks rest. They may bloom two or three times a year f given alternate forcing and drying.

Kinds: The four best species are:
Z. atamasco (Atamasco-lily)—white, spring looming in South
candida—white bloom in autumn
grandiflora (*carinata*)—rose; summer
rosea—pink bloom in autumn.

Many a housewife has learned from experience how to bring a potful of zephyranthes into bloom on the doorstep (above). Cluster of bulbs (lower right) is life size

Through regular feeding and watering, the common white calla will produce large flowers on long stems in a pot

BOOKS ON BULBS

Space limitations force us to omit many bulbous plants that are not generally grown. Those who desire more detailed information about these, or other bulbs, should refer to the following books:

The American Gardener's Book of Bulbs, by T. H. Everett. 1954
Random House, N Y. 244 p.

The Complete Book of Bulbs, by F. F. Rockwell and Esther C. Grayson. 1953
American Garden Guild and Doubleday & Co., N. Y. 352 p.

Bulbs for Beauty, by Charles H. Mueller. 1947
M. Barrows & Co., N. Y. 296 p.

The Little Bulbs—A Tale of Two Gardens, by Elizabeth Lawrence. 1957
Criterion Books, N. Y. 248 p.

Lilies of the World, by H. Drysdale Woodcook and W. T. Stearn. 1950
Chas. Scribner Sons, N. Y. 431 p.

Lilies for American Gardens, by George L. Slate. 1939
Chas. Scribner Sons, N. Y. 258 p.

A Handbook of Crocus and Colchicum for Gardeners, by E. A. Bowles. 1952
The Bodley Head, London. 222 p.

Daffodil, its history, varieties and cultivation, by M. J. Jefferson-Brown. 1951
Faber, London. 264 p.

Daffodils, Outdoors and In, by Carey E. Quinn. 1959
Hearthside Press, N. Y. 204 p.

Bulbs for Home Gardens, by John C. Wister. 1948
Oxford University Press, N. Y. 270 p.

The New Book of Lilies, by Jan de Graaff. 1951
M. Barrows & Co., N. Y. 176 p.

Bulb Growing for Everyone, by J. F. Ch. Dix. [1957.]
Pitman Publishing Co., N. Y. 147 p.

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PLANTS & GARDENS

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Editorial

Paul F. Frese, *Editor*, Constance P. Elson
and the Editorial Committee of the Brooklyn Botanic Garden

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Buhle

Snow-laden branches of magnolia

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Winter 1959-60

With pride obscuring a humble heart, we bring you our fifteenth annual digest issue of **PLANTS & GARDENS**. Fifteen articles and/or news items have been selected from the 1959 gardening and horticultural literature with the thought that these are the stories we would not want you to miss. As many readers already know, this is the Botanic Garden's way of honoring authors-of-the-year in our particular field.

Knowing that articles of special interest or significance often are written only at the behest of thoughtful editors, we want to make appropriate acknowledgment here to the editors and publishers of the magazines or other publications in which the selected articles first appeared.

With this issue, Editor Frese leaves the Botanic Garden for greener pastures, or, in truth, a greener forest (Sterling Forest Gardens). We wish him well. The last six numbers of **PLANTS & GARDENS** have been produced during his regime, and each maintains the best tradition of P. & G. Pending the appointment of a resident-editor, still to be found, we must lean on existing staff and free-lance editorial assistance.

As this goes to press, Mrs. Avery and I are about to leave for Japan on a trip made possible by a thoughtful Trustee. We are charged with the responsibility of securing some of the finest examples of ancient dwarf potted trees which the Japanese are willing to let come to America to enrich the growing collection of bonsai already here at the Botanic Garden. In due course, we will report on our success in this undertaking. Meanwhile, turn to pages 51 and 52 for current news on bonsai.

This the Brooklyn Botanic Garden's 50th Anniversary Year. We pay special homage to our Founders, and the friends who have been generous down through the years. Without their interest, energy, and personal generosity, there could be no Botanic Garden!

Sincerely,

George S. Avery

Director

A ROADSIDE CRISIS: USE AND ABUSE OF HERBICIDES *

The best management of roadside vegetation is by using selective herbicide techniques

Richard H. Goodwin and William A. Niering

IN the United States almost every family has one or more cars, and a vast number of hours is spent on the road commuting or driving for pleasure. Thus we can truly be described as a nation on wheels. The construction and maintenance of highways has become a major item in the national economy; their safety and aesthetic appearance are matters of public concern.

The vegetation along the shoulders of our highways and roadsides is essential to the right-of-way both as a stabilizer of the soil and as a pleasant and restful margin to the countryside beyond. The management of this vegetation presents a series of important maintenance problems, involving appreciable portions of our highway budgets.

The discovery of herbicides—chemicals which effectively, and in some cases selectively, eliminate plants to which they are applied—has provided a powerful and economical tool with which to manipulate the vegetation. Like many other new developments their use may be of great public benefit, but their abuse may lead to unfortunate consequences. The indiscriminate application of herbicides to thousands of miles of our roadsides has resulted in the unnecessary elimination of many of our beautiful native shrubs and wild flowers.

Highway departments are anxious to give the public good service. Some of them are spending large sums of money on ornamental plantings and even on research as to the best methods of reseeding native species along our roadsides. It seems pathetic that these efforts should be negated by the improper use of herbicides. It is the duty of the highway department to do the best job it can, and the civic responsibility of the enlightene citizen to see that this performance is u to standard.

The material presented here is intende as constructive suggestions for the correc tion of some of the abuses of herbicides

The recommendations have general ap plicability, but are especially directe toward two-lane town, country, and stat roads. They do not apply to the mainte nance of the frequently mowed grass turf on parkways or to areas under guar rails, where it may be desirable to elimi nate the vegetation completely.

What Is the Crisis?

1. Needless destruction of attractiv roadside native shrubs and smal trees,[1] and wild flowers and othe herbaceous flowering plants fre quently referred to as "noxiou weeds,"[2] which, if spared, woul enhance the beauty of the roadside
2. Inadequate root-kill of the spraye trees and shrubs (brush) on initia application so that repeated treat ments are required.
3. The spraying of ragweed in the in frequently mowed areas several fee or more back from the margin o pavement. Here, this technique i biologically unsound as a metho of control since it has the unfortun ate side effects listed under item on above.
4. The unnecessary creation of con tinuous unsightly brown swath

[1] Azaleas, mountain-laurel, blueberries huckleberries, dogwoods, viburnums, bay berry, sweet fern, winterberry, chokeber ries, wild plum and others.

[2] Daisies, black-eyed Susans, Queen Anne' lace, chicory, goldenrods, autumn asters etc.

*From *The Connecticut Arboretum Bulletin*, Connecticut College, March, 1959

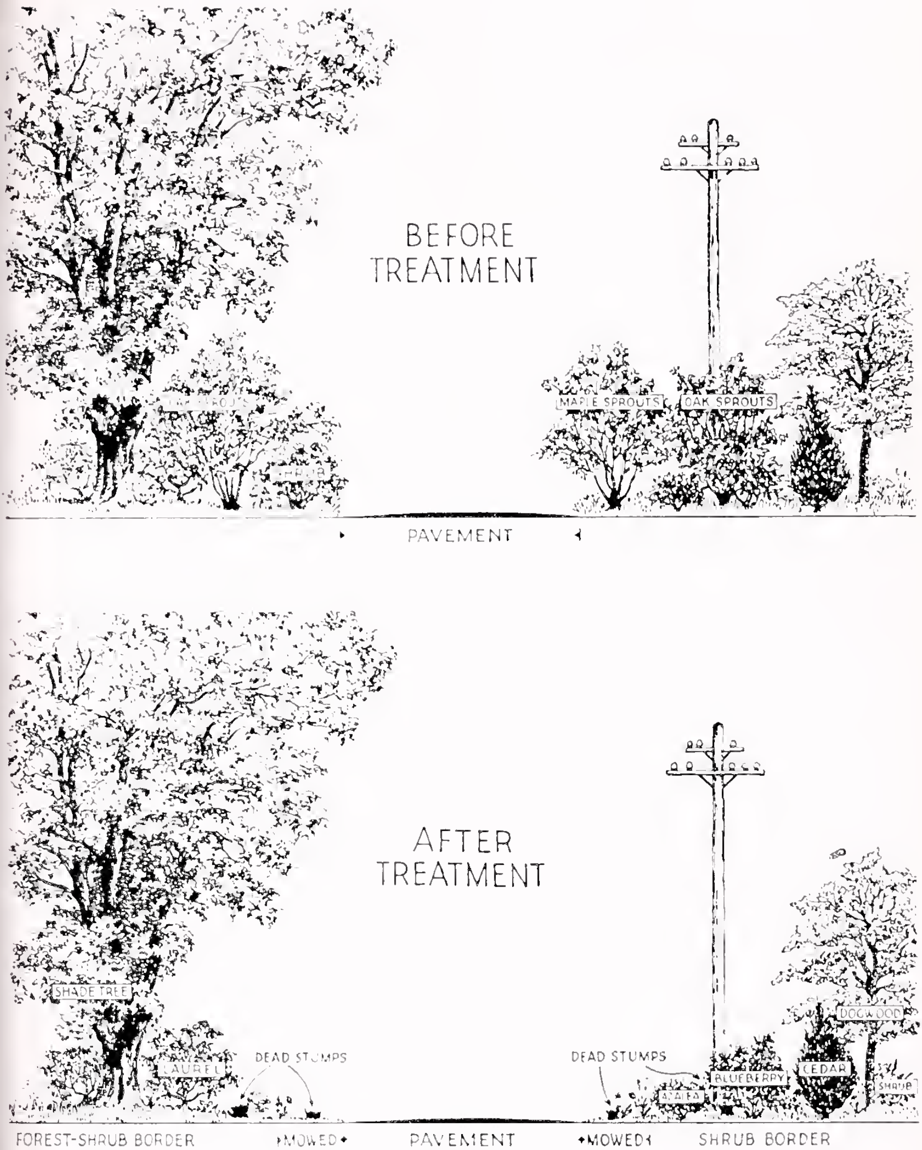

Diagram of roadside vegetation before treatment (above) showing tree sprout clumps and shrubs, some of which will be removed; and after treatment (below) with the undesirable woody plants selectively removed by herbicide treatment. Attractive native shrubs and wild flowers remain. Tree species which would grow into the wires of the utility lines have been removed. Shrubs underneath the wires and small trees adjacent to it have been preserved

along roadsides, which results from broadcast spray techniques.

5. Attractive low price-per-mile-per-spray bids offered by spray contractors careless of desirable plant types being sprayed. A quality job requires a considerably higher initial expense *but is an economy in the long run* because of the far more effective results obtained with each treatment.

Here are a few examples of the flagrant abuse of herbicides that have come to our attention. Along the narrow woodland roads of a mid-western state forest the roadsides have been indiscriminately sprayed to a depth of 16 feet. Extensive stands of pinxter azalea, blueberries, native ferns and wild flowers have been thereby destroyed.

In a southern New England town, a spray contractor finished his assignment with extra material in his tank. He discharged the contents along woodland roadsides unauthorized by the town selectman. This resulted in the elimination of the usual attractive fall wild flowers along these roads.

A New England state highway department set up specifications for roadside spraying in a state-aid program. The company receiving the contract on the basis of the lowest bid changed the state specifications from a maximum height of 4 feet to one of 8 feet without the knowledge of the highway department. The disfiguring nature of the application and the unnecessary increase in the damage to the vegetation farther back from the road was thereby greatly aggravated.

Roadside Needs

1. Adequate visibility for the motorist, which necessitates removal of certain woody growth along the roadsides, especially at intersections and the insides of curves.
2. Adequate space for pedestrians and areas where motorists can safely pull off of the travelled pavement.
3. The eradication of poison ivy, poison sumac, and any other plants specifically known to be undesirable in regard to human health and maintenance procedures.
4. A roadside attractive to the motorist whether he be on vacation or merely commuting to and from work.
5. The accomplishment of the foregoing objectives at a minimum cost figured on a long-range basis.

A Selective and Economical Approach to the Problem

The selective approach implies the elimination of only those plants which obstruct vision, interfere with other highway functions or are deleterious to human health. This involves treating the undesirable woody plants selectively rather than by non-selective broadcast or blanket spray techniques now commonly employed, since the latter will damage or kill *all* the desirable woody species as well as those to be eliminated. It also involves carefully restricting the use of herbicides to that portion of the herbaceous cover which requires attention.

A. Management of the mowed strip. Along most roadsides there is a mowed strip of varying width, behind which is frequently found a brushy margin dominated by a mixture of trees and shrubs. This mowed strip is not to be confused with the frequently-mowed turf areas along parkways. The *selective* use of herbicides may be useful in eliminating woody plants from this strip (see paragraph B below). Once established it will consist of perennial grasses and broad-leaved flowering plants which may be maintained by occasional mowing. *The broadcast use of herbicides should be avoided in this zone.* For an exception see paragraph D below. The mowed strip should be wide enough for the safety of pedestrians, and may provide wider spaces here and there for cars to pull off of the travelled pavement as the need may require. An undulating or irregular margin for the woody vegetation will enhance the attractiveness of the roadside where this effect can be achieved.

B. Management of roadside "brush."

The mowed strip is often narrow along town roads with the "brush" (trees and shrubs) encroaching right to the edge of the road. Since tree sprouts, which occur in clumps as a result of previous cutting, often obscure visibility, and their branches tend to grow out into or lean over the road, it is a common practice to eliminate such tree growth. However, the *associated shrubs need not be eliminated,* unless they interfere with sight line conditions by their occurrence in the mowed strip immediately next to the road or on the inner sides of curves.

By employing this selective approach, many attractive broad-leaved flowering plants frequently referred to as "noxious weeds," such as Queen Anne's lace, chicory, Joe Pye weed, milkweed, asters, goldenrod, etc., are preserved to enhance the beauty of the roadside. Ferns and woodland wild flowers would also be in this category.

C. Poison ivy treatment. Poison ivy can be specifically sprayed during the summer with amino-triazole (Amitrol) or 2,4,5-T, following the directions prescribed on the label, or treated during the winter by a bark spray using a 2,4,5-T herbicide.

D. Ragweed eradication. Ragweed, being an annual plant, requires open soil for its seedlings to become established each year. Therefore, by creating a dense continuous cover of other species (perennial grasses and broad-leaf flowering plants), ragweed is eliminated for as long as the cover remains intact. At the edge of the pavement and in other areas receiving continuing disturbance the establishment of dense perennial vegetation may be prevented. Whenever mowing cannot be sufficiently frequent, a light foliage spray *confined to this narrow strip* may, under certain circumstances, be useful as an annual and temporary procedure in controlling ragweed.

The Accomplishment of These Techniques

1. Only the undesirable woody species are removed.
2. Attractive native plants are preserved to enhance the roadsides, and these will tend to hinder the reinvasion of undesirable species.
3. Unsightly brown swaths are minimized or eliminated.
4. Ragweed is controlled by eliminating the sites suited for it.
5. Fewer treatments will be needed to accomplish the objectives, since better root-kill is obtained. The initial cost of the selective treatment will be higher than that for indiscriminate sprays. However, if one is interested in a high quality maintenance operation involving the points mentioned above, this approach is cheapest and of greatest public benefit.

Drift effects of indiscriminate foliage spraying along Gallows Lane, Waterford, Connecticut. *Left*, white oak twigs showing a pronounced weeping effect eighteen months after treatment. *Right*, white oak leaves abnormally curled and deformed compared to normal specimens at the right, photographed at the end of the first growing season

HARDEN YOUR HEART

Be ruthless. Beware of pity, says **Beverley Nichols** *who gives some good advice on remaking a garden fertilized, as it were, by history*

Reprinted from *Popular Gardening*, January, 1959

AFTER over 20 years of gardening, I ought to have learned the vital importance of the rules: harden your heart. Be ruthless. Beware of pity. These rules are particularly important when you are beginning a new garden. But I am a sentimental gardener, inclined to invest plants with human attributes. And when, six months ago, I entered into my latest and, I hope, final garden, I hesitated to undo the work of my predecessors. I should have rooted everything up and begun all over again with a blank sheet. But I dillied and dallied. And as a result I wasted almost the whole summer.

The garden is just over an acre, completely square, surrounded on three sides by a high brick wall built in the year 1800. When I first saw it, I was enchanted. The lawn was velvet smooth and emerald green. There were about a dozen old apple trees in full flower at the far end. There was an ancient walnut tree, higher than the house, whose branches had been twisted by time into fantastic shapes. And an immense copper beech.

And bang in the middle of the lawn was a huge bird. Not, I hasten to say, a real bird, but a topiary bird, the size of a room, squatting on top of a square of clipped yew.

As soon as I saw that bird I mistrusted it. It seemed to glare at me with a baleful expression as though to say, "Touch me if you dare!" But I had an American lady with me, and you know how American ladies are about ancient topiary work. She clapped her hands and exclaimed that it must have been there for ever so long. Forty years, to his knowledge, said the old gardener. That seemed to settle the matter.

And when I discovered that a real thrush had actually nested in the bird's neck, I felt it would be a sin to touch it. At least, until the eggs were hatched.

So the spring went by and the bird remained, and wherever one walked it almost put one's eye out. One of the first things I planned was a circular lily pool, for a garden without water is like a room without a mirror, and I made the pool two feet too wide—because of the bird. And a little flight of steps was put in the wrong place—because of the bird.

Finally I could bear it no longer, and one summer evening I made the great decision and gave the bird away. It took three strong men to get it into a lorry, and I am sure it cast all sorts of curses as it was trundled away. But at least the beastly thing has gone.

Even so, I have not been nearly ruthless enough—yet! Consider the question of the borders. They were all as straight as rulers, and I don't like straight borders. I like them to curve in and out, welcoming you and enticing you. But that meant cutting great patches in the velvety lawn and that, in its turn, meant black looks from the old gardener, and little cries of protest from the aforesaid American lady. "*How* can you dream of ruining this wonderful lawn? It's a sacrilege!"

And the contents of the borders themselves were frankly uninteresting. True, there were one or two rarities—like a cluster of pinks I had never seen before, with black centers and frilled scarlet edges, and some magnificent old gallica roses, Hippolyte and Cardinal de Riche-

Bang in the middle of the lawn was a huge topiary bird. Atop its square of clipped yew, it dwarfed even the gardener's boy

Author photo

lieu unless I am mistaken. But nothing *new* had been planted for 30 years.

No doubt there is great charm in an ancient walled garden which has been fertilized, as it were, by the shadow of history. But to deny yourself the floral benefits of modern horticulture for sentimental reasons, seems as foolish as to deny yourself the hygienic benefits of modern plumbing.

But what was I to do? Always by my side walked the old gardener who had planted all these things, and whenever I said to him, "We'd better root out those old lupines" or "There are some much more exciting varieties of phlox nowadays," I felt precisely as though I were turning his grandmother out into the street.

At last, I had an inspiration. I took him up to the annual show at Chelsea and propelled him bodily round the stalls, introducing him to all the floral marvels of the modern world. When I drove him home again he looked almost stunned, and kept muttering to himself about things being very different from the time when he was a lad. But that same night he was working late, and when I went out on the following morning the old lupines had gone, and the dreary phlox, and a dozen clumps of very boring Michaelmas daisies. They had all been piled on the rubbish heap, and a coil of smoke celebrated their decease.

As a sentimentalist I say to myself, "You were breaking that old man's heart." As a realist I know I was doing nothing of the sort. I was giving him a new lease on life and, judging from the interest with which he is now poring over the new catalogues, involving in much future cost.

Harden your heart!

When all is said and done, a garden is *you*. It is the expression of *your* personality. It is a little world to be fashioned according to *your* desire, and *your* ideas are all that matter. By all means take advice, read and listen, and learn. But . . . be yourself. Above all, don't be bullied by the past!

THE BAILEY HORTORIUM STUDIES GARDEN PLANTS

Joan Lee Faust

Reprinted from *The New York Times,* August 2, 1959

ALMOST every serious gardener at some time or other has become acquainted with the vast literature of the late Liberty Hyde Bailey. The writings of this man are the backbone of the world's horticultural data and the authority for the identification of cultivated plants.

Such valuable literature would grow obsolete in time if it were not for Dr. Bailey's own foresight. He established a Hortorium to watch over his writings and the nomenclature and identification o cultivated plants. It is the only institutio of its kind in the world.

Too few people are aware of the Libert Hyde Bailey Hortorium's existence. I occupies several large offices on the fourt floor of the A. R. Mann Library at Cornel University. In the heart of the College o Agriculture, the Hortorium has the us of its own library of 7,000 books in addi tion to the 40,000 volumes in the Man Library. There is an extensive herbariu of nearly 300,000 specimens and a larg photo and periodical collection.

Dr. Bailey's original plan in foundin the Hortorium was to create a place wher garden plants could be named, classifie and documented. He coined the wor himself from the Latin, *hortus,* meanin garden.

In the early days of the Hortorium th work was done at Dr. Bailey's property Sage Place, near the Cornell campus i Ithaca, N. Y. As the work proceeded th herbarium cases, books, records and re search files taxed the space in the ol stable, and the offices were moved to th present location on the campus in 1952 The grounds and buildings of the Baile estate along with the Hortorium belon to Cornell University, a gift from D and Mrs. Bailey in 1935. Dr. Bailey' daughter, Miss Ethel Zoe Bailey, lives a Sage Place and is an untiring curator o the Hortorium staff.

The present staff has four men wit doctorates in taxonomy, plus an efficien retinue of clerical workers. The profes sional staff not only serves as full-tim

Cornell University photo

Staff members use a counter by herbariu cabinets as handy workspace when studyin specimens

Miss Ethel Zoe Bailey and Dr. George H. M. Lawrence check cards in the master plant index

researchers but they are able assistants to the graduate students in taxonomy.

Some teaching is done on the graduate level. Dr. George H. M. Lawrence, the present director of the Hortorium, worked with Dr. Bailey for many years. He became director when Dr. Bailey retired in 1951 and his guidance resembles closely that of its founder.

Seek and Find

A lot of the time at the Hortorium is spent searching into the identity and proper classification of cultivated plants. A vast card file is kept of plant sources all over the world and the catalogue collection is one of the largest. Its entries date back to 1791 with the catalogue of William Prince, Flushing, N. Y.

The value of such an institution's research is realized only if it is made available. To this end the Hortorinm has maintained a well-traveled bridge between its findings and nurserymen, gardeners and plant hunters. Over 3,200 letters are received each year from nurserymen, plant collectors, gardeners and hybridizers searching for sources, identification and vital particulars on plants. The staff is not equipped to answer queries on cultural and pathological problems, and in fact, discourages them.

Perhaps the biggest assignment for the Hortorium is production of up-to-date editions of Dr. Bailey's three most widely used writings—the Cyclopedia of Horticulture, Manual of Cultivated Plants, and Hortus.

At present the staff is revising Hortus, Dr. Bailey's dictionary of gardening. Its last revision was published in 1941 and the new edition should be ready in the near future.

According to Dr. Lawrence, 6,700 new species have come into cultivation since the last revision, and perhaps a quarter of those have dropped out of circulation. As an illustration he noted how the rock garden fad has been overshadowed by the recent demands for decorative foliage plants, indoors and out.

The revision work on Hortus is divided among the staff. Those that are especially versed in certain categories of plants go about refining the data, reclassifying and checking its nomenclature. New plants that make their appearance during the years are tested, when possible, in the Hortorium's trial plots to determine if the plant is actually a new species or an old-timer being revived.

Though the staff members are trained as botanists they have to think like horticulturists. Botanists can key down native plants fairly easily by geographic area. Cultivated plants, on the other hand, are introduced from one part of the world to another. The staff has to rely on the world's literature of cultivated plants.

In addition to research and the book revisions each staff member is allowed three months leave of absence during the year to do research in a category of plants of his own choosing. He may travel to any of the four corners of the earth and the trips often result in monographs or additional clarifications on certain plant nomenclature.

When the Hortorium completes its revision of Hortus, work will start on the three volume Cyclopedia of Horticulture. For this, the illustrative work has already begun.

In this winter landscape, trunks and principal branches in the tree group at left are from selected roots, thinned out, to which cuttings from western tree lichen have been cemented for suggesting the lesser branches and terminal twigs. Blending of the two components was accomplished by giving both a common color and texture through sprayings and siftings. The weathered and twisted dead trunk at right is from shrubby cinquefoil. For the slender, brushy forms beyond the stream, filament-like blossoms from smoke bush were used. The water is glass and the snow is table salt

THE WORLD IN MINIATURE

John L. Hawkinson

Reprinted from *Nature Magazine*, February, 1959

IT was during a visit to Japan in 1920 that I had my first glimpse, at an art exhibition, of those skillfully contrived tray landscapes known as *bonseki* and *bonkei.* I was fascinated by them, and then and there determined that some day I would try to work out a "western" version of these works of art—one less circumscribed, perhaps, by rigid rules of traditional procedure and treatment.

It was not until seventeen years later that I was able to do something about this dream. An intermediate step had done much to prepare the groundwork. I had acquired a readily accessible tract of country land, some ninety-odd acres of woods, and a meadow with a brook. Spare-time forays into this property heightened an already keen interest in the out-of-doors.

Such continued delving led me inevitably to the intriguing fact that nature abounds in repetition. The largest forms, if not quite duplicated, at least are again and again closely approximated through a range of lesser scales that descend down into microscopic levels. Missing or differing color and texture make such similarities less obvious, yet the *forms* still are there where anyone may find them.

Reasoning from this premise, if desired color and texture elements somehow could be supplied, might not these ready-made small forms be adapted, rearranged and variously combined for purposes of representing the landscape in miniature?

The dioramas shown on these pages are some of the results of more than twenty years of trial-and-error in developing a basic technique, and yet I feel that I still have barely scratched the surface of the ultimate possibilities of the art.

A snow scene, done for a photographic Christmas card, in which the large tree-top behind the cottage is of bare Joe Pye weed tips, bunched. The vertical foreground form, seen in part at left, is a spike of steeple-bush blossom. Low shrubs in gap are of clematis seed heads, the others from smoke bush. On ground and cottage roof, snow is table salt; on trees and shrubs it is an application of aerosol spray sold for decorating purposes

This glimpse of "swamp country" was put together for a camera study. Island at right, shaped from wallboard, was surfaced with real moss for a rough grass effect. Tree trunk and stump were root fragments, somewhat thinned, from shrubby cinquefoil. Streamers of moss were wool yarn, given texture by sifting after adhesive spray. For the foliage on the near-dead tree, and for scrubby growth edging the water, clematis seed heads were used for the basis of form, with various siftings applied. Window glass made the calm water. Sky and distant horizon, from a Kodachrome slide, were rephotographed on a single negative with the foreground elements

This diorama, from a sketch thought to have been of the Mark Twain birthplace in Hannibal, Missouri—later identified as *Huckleberry Finn's house*, next door—has foliage done with sprays and siftings over a clematis seed-head base, as was the "climbing rose" along the edge of the porch roof. Slender-trunked flowering tree is a bit of smoke bush blossom cemented to a piece of root. Spruce branches are small cuttings from an evergreen glued to a tapered trunk. Grass tufts are from cat-tail

Author photos

Connecticut's historic "Charter Oak,' blown down during a summer storı in 1856, was estimated to have beeı more than a thousand years old. Showı here, partly completed, is a miniatur version done in 1939 as an experimen in tree portraiture. A popular engrav ing was used as a pattern in simulat ing the essential branch structure which was contrived by combinin carefully chosen parts from mapl roots. Contours of the massive trun were approximately by modeling iı plastic wood

This is the Charter Oak as it appears today in its diorama setting. Without altering the tree's distinguishing characteristics, a fuller more vigorous foliage was given it to represent the tree at an earlier date, more as it might have appeared when the charter was concealed in its hollow trunk in 1689. Leaf masses here are made from seed heads of wild clematis, on which a sequence of pre-colored materials have been sifted after an adhesive spray

In this diorama *Noah's Ark Under Construction*, done for the Mariner's Museum at Norfolk, Virginia, the scale is only a sixteenth-inch. Variation of treatment and choice of siftings permit a degree of scale latitude while still using the same group of natural materials

Some twigs—usually the more complex, close-branching kinds—are adaptable for tree building. The sturdy form, (above, left) shown as found, came from a scrubby wild apple tree in a pasture. It can be much improved by thinning and rearranging. In photograph at upper right, four lower branches have been removed, along with one or two that formed the original top. The trunk has been shortened about two inches, and a kink filled in. Three of the eliminated branches have been reattached to give the whole a more pleasing outline. All loose bark has been scraped away for more secure bonding-on of foliage elements

Leaving parts of the branch structure exposed, cuttings from prepared clematis (lower left) have been cemented in place to conceal too-heavy terminal tips. Here and there, as character notes, tips have been left uncovered to suggest dead or dying limbs and stubs. After transfer to its diorama setting (below, right) surrounding forms help give the 12-inch tree a look of stature and realism. In ¼-inch scale, it represents a real-life height of 48 feet

WOODY PLANTS THAT ARE DIOECIOUS

The word literally means "two households"— botanically it indicates that plants are of separate sexes

Donald Wyman

Reprinted from the *Arboretum Bulletin*, Summer, 1958

SOME groups of plants have pollen-bearing (staminate) flowers all on one plant and ovary-bearing (pistillate) flowers all on another plant; in other words, they are dioecious. At first glance, this may not appear very important. However, a knowledge of their flowering and fruiting habits before they are selected would make all the difference between success and failure, if colorful ornamental specimens were wanted.

One time, I visited a very extensive garden in central New York. The owner did much of the work herself and was rather proud of her gardener's "know-how." In the garden was a large, old-fashioned pergola completely covered with a beautiful bittersweet vine (*Celastrus scandens*). The reason I had been invited to visit the place was to determine just why this vine failed to fruit. It had been growing in this featured spot for fifteen years, tenderly cared for, fertilized with all sorts of mixtures to make it "produce," yet in all that time not a single fruit was borne. Of course, it was a male or pollen-producing plant and never would fruit. However, it could have been a pistillate or fruiting plant which was far removed from a pollen source so that the flowers were never fertilized. In either case, it could not provide colorful fall fruit.

There are at least three dozen genera with species that are dioecious. They are as follows:

Scientific name	*Common name, if any*
Acer	Maples; many species
Actinidia	
Ailanthus	Tree of Heaven
Aucuba	
Baccharis	
Celastrus	Bittersweet
Cephalotaxus	Plum-Yew
Chionanthus	Fringe Tree
Comptonia	Sweet Fern
Cotinus	Smoke Tree
Diospyros	Persimmon
Ginkgo	
Helwingia	
Hippophae	Sea Buckthorn
Ilex	Holly; many varieties
Juniperus	Juniper
Lindera	Spice Bush
Maclura	Osage Orange
Morus	Mulberry
Myrica	Bog Myrtle
Nemopanthus	Mountain Holly
Orixa	
Phellodendron	Cork Tree
Populus	Poplars
Rhus	Sumac
Ribes	Currants
Ruscus	Butcher's Broom
Salix	Willow
Schisandra	
Securinega	
Shepherdia	Buffalo Berry
Skimmia	
Smilax	Green-Brier
Taxus	Yew
Vitis	Grape
Zanthoxylum	

Some of these genera are not valued for their ornamental fruits, so it makes little difference whether staminate or pistillate plants are grown. With some of the

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Male flowers of holly (*left*) are borne in clusters and produce pollen, but no berries. Female flowers of holly (*right*) produce berries if pollinated. Male and female flowers are borne on separate trees; to insure pollination (chiefly by bees) at least one tree in every planting should be a male

others it makes a great difference. For instance, the Tree of Heaven (*Ailanthus altissima*) has seeded itself over wide areas of our urban wastelands, and will grow under the most trying conditions where no other tree will do well. When fully open, the staminate flowers give off an obnoxious odor—the reason this type should not be grown. The fruits of the pistillate plant, on the other hand, can be very colorful in the fall.

The brilliant red fruits of *Aucuba japonica* can only be insured if staminate and pistillate forms are growing together in the near vicinity.

A few years ago, I did some experiments with the *Celastrus* clan which proved that wind-carried pollen was effective in fertilizing the pistillate flowers at a distance of at least 100 feet. Undoubtedly wind-blown pollen is effective at much greater distances.

In other experiments, pistillate plants of *Celastrus scandens* were planted next to staminate plants of *C. orbiculata,* and in other instances the procedure was reversed. In both cases, normal pollination and fruiting took place, showing that with *Celastrus*, fruiting or pistillate plants can be fertilized with the pollen of other *Celastrus* species.

Experiments were carried out with *Chionanthus retusa* which proved that this particular plant is polygamo-dioecious. *Chionanthus virginica,* on the other hand, is dioecious. *Morus alba* and *Morus alba tatarica* have both pistillate and staminate flowers on the same branch.

Most hollies are notably dioecious, but *Ilex cornuta* is the rare example of a plant which, in its pistillate form, will produce red fruit without pollinization. Of course, viable seeds are not produced in such instances, but from an ornamental standpoint, pistillate plants are the only ones worthy of growing in the garden. In other experiments a plant of *Ilex laevigata* performed similarly.

Pistillate plants of *Gingko,* also in this dioecious group, bear fruits that have an obnoxious odor, resulting in the pistillate form being on the black list for garden planting.

Holly, yew, and bayberry are planted primarily for their fruit and both sexes must be planted near together to insure the pistillate plants fruiting. Usually, the staminate plant is placed in the background, or if in a massed planting, one staminate plant to five to ten pistillate plants.

With vines like bittersweet, a staminate vine could be planted in the same hole with a pistillate vine. I have had excellent success with cutting a handful of flowering branches from the pollen plant and hanging them in a bottle of water in the middle of the fruiting plant. As flowers open, insect, wind and gravitation usually will do an excellent job of fertilization.

GERMINATION

Many plants have evolved natural mechanisms that keep their seeds "dormant" until the optimal time for sprouting. These mechanisms include chemical responses to light and rainfall

Dov Koller

Condensed from *Scientific American,* April, 1959

IN parts of the world where one season is sharply contrasted with the next, the transition from the harshest season to the mildest is heralded by a tinge of green on hill, valley and plain. Not even the humblest roadside, back yard or refuse dump escapes the gentle arrival of new plant growth. Some of this growth is represented by the sprouting buds of established plants, but part of it is due to the shoots of newborn seedlings, sprouting from seeds that earlier in the year might have passed for inanimate crumbs of soil. It is this transformation of seed to seedling that we call germination.

To the farmer or the gardener germination seems as inevitable as the progression of the seasons. He expects every seed in his planting to sprout, or else! Meanwhile, beyond his field or garden, the seeds of wild plants also sprout in profusion. But were he to try to cultivate some of these wild plants in a similar manner, the odds are that only a pitifully small proportion of his seeds would germinate.

People who have tried and failed to grow wild plants from seed often conclude that the seeds that do not germinate are dead. Yet it would surely be paradoxical if a plant expended energy, time and material in making dead seeds. Such a plant would be a poor evolutionary prospect indeed. Investigations spurred by this paradox have shown that practically any seed can be made to sprout under the right conditions and at the right time. We could say that when we cannot cause a seed to germinate, the fault is not the seed's but ours.

If we take for granted the dependable germination of a commercial seed, that is a tribute to the talents and perseverance of the generations of farmers, gardeners and seedsmen who have bred it not only for beauty or utility, but also for full prompt and uniform germination. For the farmer and gardener such readiness to germinate is an advantage, but for the wild plant it is a hazard. A readily germinable wild plant would literally put all its eggs in one basket; total germination if followed by drought or disease, might lead to the total destruction of the species. Thus for most wild species a reluctance to germinate is a condition for survival since it ensures the maintenance of seed reserves for later germinations.

The essential part of the seed is the embryo it encloses. The embryo starts out as a single cell—the fertilized egg—and ends up by becoming a tiny plant consisting of a miniature root and shoot. In the usual course of development the growth of the embryo stops completely when the seed ripens. Plants that are viviparous, that is, plants in which the embryo continues to grow on the mother plant, are either genetical freaks or very specialized. The embryos of the swamp-dwelling mangrove tree, for example, grow into foot-long, javelin-like seedlings while they are still attached to the mother plant; then they plunge from the tree to embed themselves in the bottom of the swamp. In most plants, however, the ripe seed becomes detached from the mother plant some time after the embryo has stopped growing.

The embryo thus takes the first step to-

ward an independent existence, but it rarely takes that step unequipped. Accompanying the embryo on its journey into the unknown are several tissues and organs: a food supply, a seed coat and sometimes certain tissues of the fruit, flower, specialized leaves or other organs. The entire structure is known as the dispersal unit.

Many parts of the dispersal unit serve fairly obvious functions. Thus the stored food nourishes the embryo until it becomes a self-sustaining seedling, the enveloping seed coat protects the delicate body of the embryo and its food supply, and so on. Many things in the make-up of the dispersal unit serve to determine the fate of the embryo it accompanies, and to some extent the fate of the plant which will grow from it.

One such function is the control of the distribution in space of the progeny in relation to the parent plant. Another is the avoidance of prompt, uniform and indiscriminate germination. Both functions operate in the preservation of the species by decreasing the probability of chance annihilation.

Distribution in Space

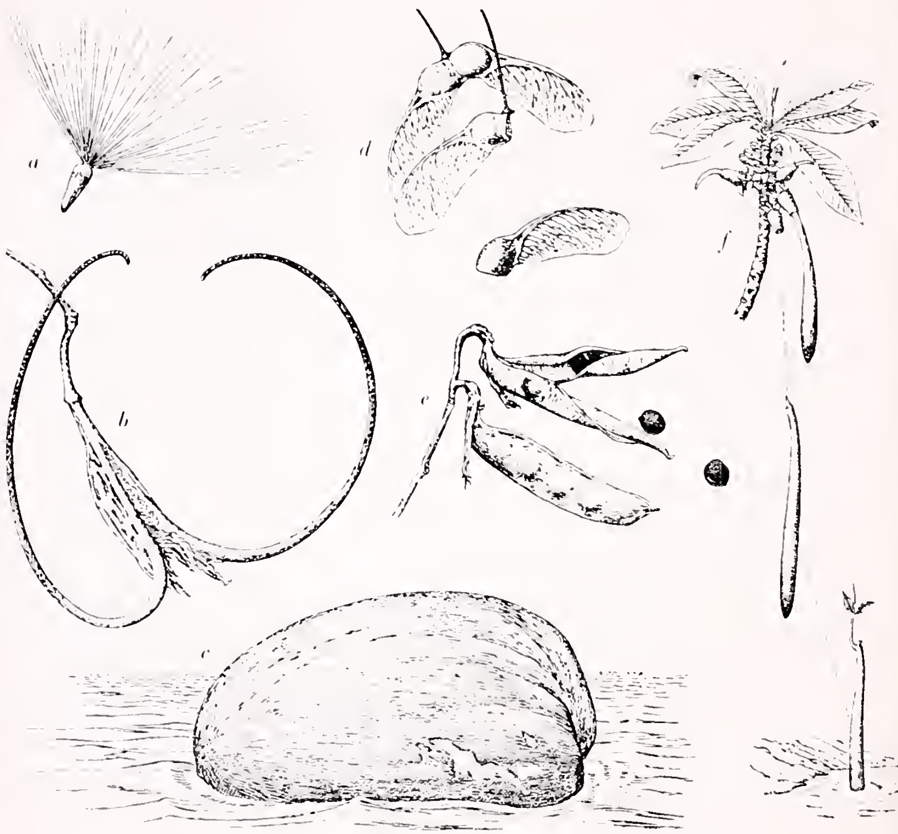
Many dispersal units are adapted to make use of some special environmental agency for the control of dispersal. Wind is a typical agency. It can move dispersal units equipped with parachutes (*e.g.*, lettuce, thistle) or wings (*e.g.*, maple) over great distances. The same agency, but a different method, transports the various tumbleweeds (*e.g.*, Russian thistle). Here, after seed ripening, the entire shoot breaks off at the base and rolls before the wind, scattering seed as it goes. Water is a second agency, carrying buoyant dispersal units such as coconuts to distant shores.

A third agency is aerial humidity, which operates in a variety of ways. In some species (vetch, weaver's broom, *Impatiens*, geranium) the fruit comprises strips of tissue joined edge to edge. As the fruit dries, tension between the strips increases until they part explosively, dispersing the seed. In other species the dispersal unit is equipped with humidity-operated devices for self-burial. The wedge-shaped dispersal units of the wild oat and stork's-bill have a long, humidity-sensitive tail that coils into a tight spring when it is dry and uncoils when it is moist. Barbs projecting from the wedge allow it to move only in the direction of its point. With daily variations in humidity the tail coils and uncoils repeatedly, driving the barbed wedge forward until it meets an obstacle or reaches a depth where humidity is constant.

Animals are a fourth agency of seed

Seeds of mustard plant are scattered when pod bursts. However, some seeds are retained in the "beak" of the pod (upper part of center pod), which disperses them later when it bursts

dispersal. The dispersal units of some plants (cocklebur, devil's-claw) carry hooks that catch and tangle in animal fur. Others (the puncture vine) have sharp, strong barbs that pierce horny paws. Nonpoisonous dispersal units with a tasty or nutritive fruit attract animals which propagate the seed in a variety of ways. Many small-seeded berries, such as grapes, are eaten whole; the seeds of such plants are carried off in the animal's stomach and excreted without loss of viability. Other dispersal units are harvested as food by ants, mice or squirrels. Some fruits (*e.g.*, bitter brush) are collected for their pulp, and the inedible seeds are left to germinate in the nest. Some seed-eating animals are too prudent, collecting more than they can consume; others cannot keep track of their numerous caches, thus leaving many seeds to germinate. The juicy, sticky fruit of the parasitic mistletoe is well adapted to dispersal by birds because it adheres to their beaks and is wiped off upon a new host branch. A remarkable dispersal unit is the fruit of the squirting cucumber, which contains a sticky fluid under great hydrostatic pressure. When it is disturbed by a passing animal, this fruit bursts, squirting its seeds in a powerful jet of fluid that glues them to the animal's skin or fur.

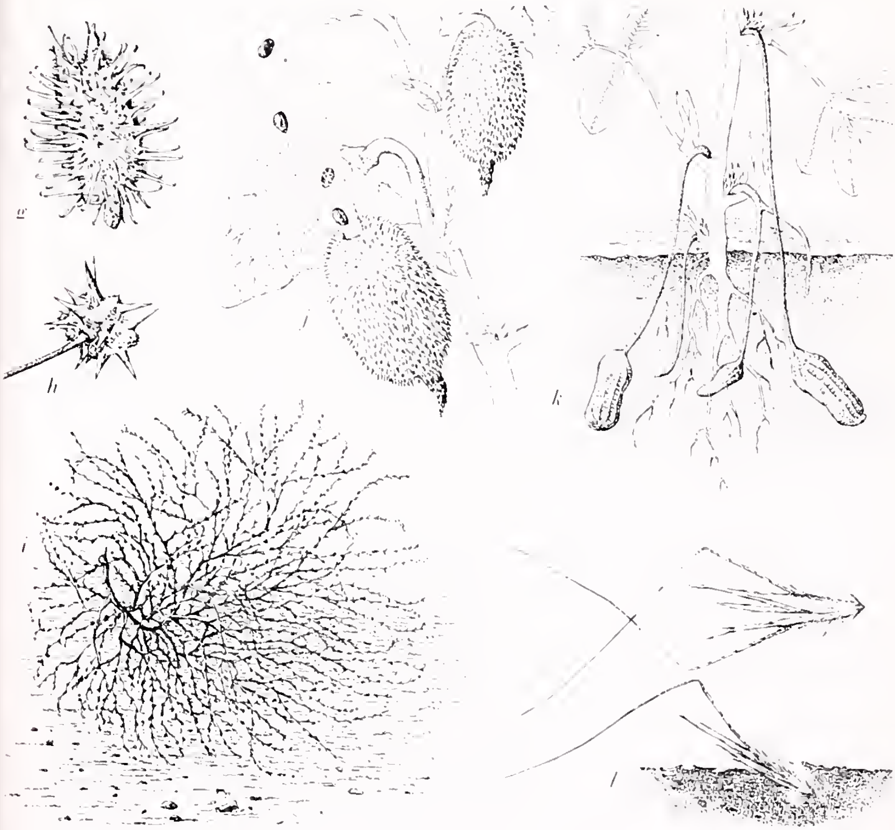


"Dispersal unit" of a plant is its seed plus other equipment, some of which is responsible for the dispersal of the seed by wind, water or other agencies. The fruit of the thistle (*a*) is airborne. The devil's-claw (*b*) and the cocklebur (*g*) are dispersed when they catch in the fur of animals. The coconut (*c*) travels by water. The fruit of the maple (*d*) glides on wind. Vetch pods (*e*) pop when they dry, expelling their seeds. The mangrove (*f*) is atypical in that it sprouts on the parent plant and then falls.

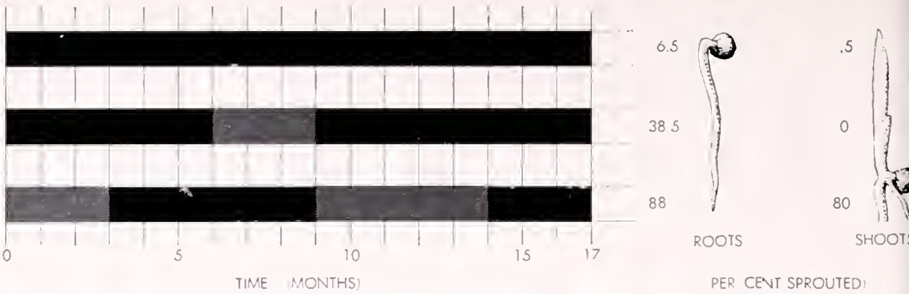
While many plants have evolved methods of dispersing their seed over great distances, a few species have achieved the opposite extreme: deliberate prevention of dispersal. "Anti-dispersal" of seed can be observed in the peanut and subterranean clover, the fruit of which develops at the end of a long stalk. The stalk actively grows down into the ground, thus burying the seeds in the immediate vicinity of the parent plant.

Regulated Germination

Plants can control not only their distribution in space but also their distribution in time. In many species few, if any, of the seeds will exhibit readiness to germinate soon after ripening, but over the years more and more will do so. One example is provided by some species of mustard plant, in which only a part of each fruit opens after ripening. The seeds that are released from the fruit germinate readily, while the rest remain enclosed in the "beak" of the fruit. Their germination is thus delayed considerably. Another example is provided by many species, notably legumes, in which the embryo is denied access to soil moisture by being enclosed in a waterproof seed coat or fruit coat, thus effectively preventing its germination. The gradual relaxation of imper-



The puncture vine (*h*) is dispersed by spikes which puncture the paw of an animal. The entire shoot of the tumbleweed (*i*) is a dispersal unit which scatters seed as it rolls before the wind. The squirting cucumber (*j*) ejects its seed in a sticky jet when it is touched. The peanut plant (*k*) is an example of "anti-dispersal": instead of dispersing its seeds, it keeps them on a leash. The barbed dispersal unit of the wild oat (*l*) is pushed into the ground by humidity-driven coiling and uncoiling of its long "tails"



Temperature triggers germination in the snow trillium, as shown in an experiment by Lela V. Barton. *Top bar:* At a steady warm greenhouse temperature for 17 months, only 6½ per cent of the seeds produced roots, ½ per cent shoots. *Middle bar:* With 6 months in warm greenhouse, followed by 3 months "winter" (shaded light gray), then 8 months warm greenhouse, 38½ per cent germinated but produced only roots. *Bottom bar:* Two winters, each followed by a few months of warm greenhouse, gave excellent germination, with both root and shoot growth

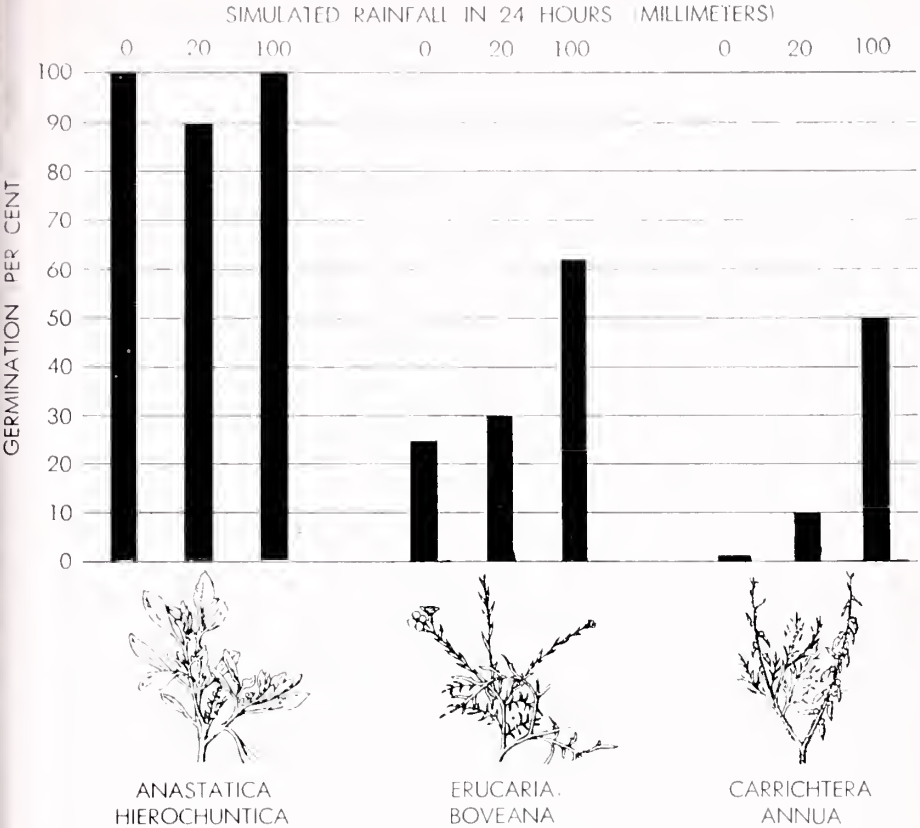
meability makes a small fraction of the seed population ready to germinate at any given time. Many years may thus pass before all the seeds of a given crop are germinable. In some of these "hard" seeds the impermeable coat must actually disintegrate. The more elaborate seeds of this type have ingenious valves operated by such environmental factors as atmospheric humidity.

The events that trigger germination sometimes suggest a highly specific adaptation to the environment. In California, sumac proliferates after a forest fire because the fire causes a waterproof layer of the dispersal unit to become permeable. The localization of certain plant species in pastures are traceable to the fact that their hard seeds are made water-permeable by bacterial action as they pass through the digestive tract of ruminants. Far from damaging the seeds, this process enhances their prospects for germination, and moreover deposits them in a moist, manured environment. The open range is thus kept well stocked with pasture plants. This arrangement sometimes backfires, however, allowing undesirable plants such as mesquite to overrun the range and oust more desirable species.

Today botanists are exploring a new realm of mechanisms that regulate germination more specifically than by mere dispersal in time. These mechanisms help to determine the timing and locality of germination by restraining it in environments and seasons that do not afford a reasonable chance for the plant to complete a life cycle "from seed to seed." Typical of these newly discovered mechanisms is that of chemical regulation, now under investigation in the Earhart Plant Research Laboratory of the California Institute of Technology and in the Department of Botany of the Hebrew University in Israel.

Clearly there is no worse place for a tomato or melon seed to germinate than inside the growing parent fruit; such vivipary would be highly disadvantageous. The warm, moist flesh of the fruit provides just the sort of environment in which the seeds might be expected to sprout, yet they rarely do. How is germination delayed until the fruit has fallen and decayed? The prevention of vivipary in most fleshy fruits is due to the presence in them of substances that specifically inhibit germination. Only when the seeds are free of the pulp and juice will they germinate.

More dramatic are the "chemical rain gauges" found in many dispersal units. These are inhibitory substances that are water-soluble, and are therefore readily leached out by rainfall. The amount of inhibitor in the dispersal unit is apparently adjusted so that the amount of rainfall needed to leach it out sufficiently to permit germination will at the same time moisten the soil sufficiently to ensure the plant's subsequent growth. In the dis-



Rainfall triggers the germination of many desert plants. This chart illustrates the results of experiments by A. Soriano, who subjected desert plants to artificial rainfall. The seeds of all three species shown here were kept in moist soil. Only *Anastatica hierochuntica* did not require considerable extra rainfall to leach out a chemical that inhibited germination

persal units of wild smilograss (*Oryzopsis miliacea*), local varieties are "gauged" to the rainfall pattern of their habitat. The importance of such rainfall-dependent germination control for the survival of plants in arid or semiarid zones, where rainfall is limited and erratic, will be self-evident.

Another regulatory mechanism found in many dispersal units is the "temperature gauge." In its simplest form the temperature gauge restricts germination of a species to a specific temperature range that is often very narrow and precise. This then distinguishes plants that start their lives in cool climates and seasons from those that do so in warm ones. More highly developed regulation by temperature is found in plants that will germinate only when they are submitted to a specific change in temperature. Most common are the "cold-requiring" seeds, the subject of extensive research at the Boyce Thompson Institute for Plant Research in Yonkers, N. Y. In order to germinate, these seeds require either one or two prolonged exposures (each of several weeks) to near-freezing temperatures, alternating with one or two exposures to higher temperatures. The apple, the peach and other plants that exhibit such mechanisms are invariably denizens of temperate climates; their ability to avoid germination before prolonged exposure to cold is of high sur-

Germination of a lettuce seed is depicted in these drawings. At first the seed lies "dormant" in the soil (a). Then, in response to environmental stimuli, a root sprouts (b). Finally the shoot sprouts, leaving behind the outer covering of the seed (c)

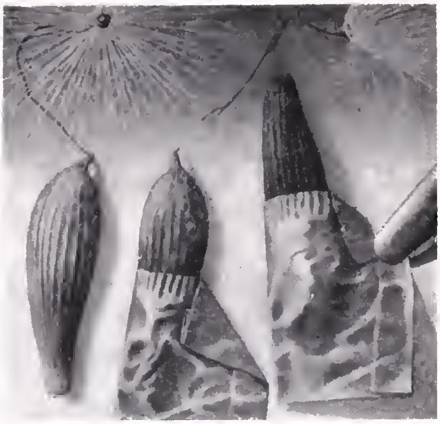
vival value, since it minimizes the danger that seeds may germinate before the hazard has passed.

Low Temperature and Light

Especially mystifying are the workings of the temperature gauge close to the freezing point. As yet we have been unable to perceive any of the low-temperature processes at the time they take place. Our only indication that something has indeed been going on is the subsequent growth at higher temperatures. We have as yet no means of distinguishing between a cold-treated seed and an untreated one, except by germination. Under certain conditions the naked embryos of cold-requiring seeds can be coaxed to grow without cold, but these embryos invariably give rise to plants with dwarfed, unextended shoots. The dwarfism is maintained as long as cold is denied. When the seedling is exposed to cold, it starts to grow normally. Recently it was shown that the plant-growth substance gibberellin will substitute for the cold treatment of dwarfs. Gibberellin also substitutes for cold in the so-called rosette plants, such as endive, where cold treatment causes elongation of stem and flowering. The nature of the relationship between gibberellin and the cold processes has been the subject of intensive research, but it is as yet unclear.

Another common, though even less understood, response to temperature variation is "diurnal thermoperiodicity," a characteristic of plants that germinate far better under daily alternations of warmth and cold than they do at any constant temperature. Ecologically, such a mechanism can prevent germination in climates, seasons or soil depths where proper temperature alternations do not occur. Physiologically, we have almost no clue to the operation of the mechanism.

Dispersal units incorporate not only rainfall and temperature gauges, but also sensitive mechanisms that respond to light. Such a mechanism in the humble lettuce plant is the subject of research at three research institutions (the U. S. Department of Agriculture laboratories at Beltsville, Md., the Hebrew University in Israel and the University of California at Los Angeles). In darkness lettuce seeds germinate tolerably well only within a narrow temperature range. Given light they germinate promptly and uniformly



This illustration shows three lettuce seeds as they would appear under a low-power microscope. Attached to the seed at left is the feathery parachute by which the wind bears the lettuce seed away from the parent plant. This drawing represents an experiment in testing reaction of lettuce seed to light. It is known that red light will stimulate the germination of a lettuce seed and that "far red" light will inhibit this stimulation. Two of the seeds at right have been wrapped in metal foil to determine whether any particular part of the seed is involved in these responses

over a very wide range, and under a variety of conditions that would absolutely inhibit germination in the dark. Dry lettuce seed is insensitive to light, but a few minutes after the seed is moistened it becomes light-sensitive, so sensitive that exposure for a few seconds to light with an intensity of a few foot-candles suffices to produce the full effect. The obvious analogy to photographic exposure extends further: If a soaked seed is exposed to light and then dried, it will retain the "message" it received and, when it is subsequently remoistened, it will germinate in darkness.

A search of the light spectrum for the most effective wavelengths has shown that only the red portion of the visible spectrum stimulates germination. At the same time it was found that far red light (on the boundary between the visible red and the infrared) is capable of reversing the stimulation by red light, thereby inhibiting germination. A flash of red stimulates germination. A flash of far red, following closely, completely reverses the stimulation. This reversal is itself reversed when followed closely by another flash of red, and so on repeatedly. It is always the color of the final light-flash that is decisive. Our understanding of this mechanism is fragmentary. As in the case of the near-freezing of seeds, the results of the process are not immediately visible. We only perceive their end products, namely subsequent germination or nongermination in darkness.

Sensitivity to light implies the presence of a pigment that absorbs the light. The effects of the red and far red indicate some properties of this pigment, but it has yet to be extracted, purified, identified and studied — a process that may take some time, since the pigment doubtless occurs in minute amounts.

It may be significant that gibberellin and another plant-growth substance, kinetin, simulate the red-light stimulus that triggers germination, but to complicate matters several substances (*e.g.*, potassium nitrate and thiourea) which are not known as plant-growth regulators, also do so. Another complication is the fact that germination apparently loses its sensitivity to light when the embryos are decoated. It remains to be seen whether light acts on the embryo, somehow making it grow with vigor sufficient to overcome the resistance of the coat, or whether it works on an extra-embryonic entity, perhaps by activating an inhibitor in the coat.

Like a photographic plate, seeds can be over- and under-exposed. The brief flash of light that stimulates germination in lettuce and tobacco plants would be insufficient for the rush *Juncus maritimus*; on the other hand, although continuous illumination works as well as a flash in the case of lettuce, it would inhibit wild smilograss or the Negev salt-bush, plants fully stimulated by a brief exposure.

We can deduce some implications of this mechanism for the ecology of plants. Sensitivity to the period of light and dark may determine the season of germination just as it determines flower initiation and the onset or end of dormancy in the buds of trees and shrubs. Inhibition by overexposure to light may be of value in preventing germination from occurring on an exposed soil surface, where treacherous conditions such as rapid drying or high temperature are common. This may be why the germination of many desert plants is inhibited by overexposure. Conversely, inhibition by underexposure may be of value in preventing germination from taking place in poorly illuminated or overpopulated localities. This may explain why many aquatic and marsh plants require light for germination.

It should be said that this account has described only a few of the better known germination-regulating mechanisms. Moreover, it must be understood that several mechanisms are often found in a single seed. A well-known example of interdependent mechanisms occurs in the ordinary garden cress, which germinates only in response to a combination of light and temperature stimuli. *Trigonella arabica*, on the other hand, is a desert annual that has a dispersal unit equipped with at least four independently operating controls: a water-soluble inhibitor, a "hard" seed coat and sensitivity to both temperature and light.

Germination and Evolution

The life of every plant includes critical phases at which it is more than usually susceptible to the vicissitudes of the environment. Apparently it is at these phases—the change from seed to seedling, from the active to the dormant bud and vice versa, from the vegetative to the flowering plant—that regulatory mechanisms, operated by environmental signals, are particularly important. Taken together, they serve to maintain the harmony of the plant and its environment. The regulation of germination does more than this: it also acts to preserve the species by conserving embryonic material and by helping to select a favorable environment for further development of the offspring.

In evolutionary terms the origin and spread of these regulatory mechanisms may be easily imagined. Once created, whether by mutation or the reassortment of genes, the higher survival value that they imparted to their bearers provided the latter with distinct advantages over their kin that lacked these advantages. Selection and breeding by man have in many cases reversed this process, producing plants that germinate at man's will rather than in response to natural signals. These tame plants have minimal germination control. On the other hand, nature's own selection and hybridization have been, and apparently still are, tending toward more efficient control and regulation of germination, as a means for the preservation of plant species.

Longevity of Well-stored Seeds

Most seeds retain their viability best if stored in a relatively dry place, and at low temperatures. Properly stored seeds remain viable for the number of years indicated:

1 year: corn, onion, parsnip, okra, parsley; delphinium, candytuft.

2 years: beet, pepper, leek, chives; aster, strawflower, sweetpea.

3 years: bean, carrot, celery, lettuce, pea, spinach, tomato; phlox, verbena.

4 years: cabbage, cauliflower, Brussel sprouts, Swiss chard, kale, squash, pumpkin, radish, turnip.

5 years or more: cucumber, endive, muskmelon, watermelon; cosmos, Shasta daisy, hollyhock, marigold, nasturtium, pansy, petunia, pink, scabiosa, stock, sweet alyssum, zinnia.

from Introductory Horticulture, by E. P. Christopher. p. 482. McGraw-Hill Book Co., N.Y. 1958. ($7.50).

Orchids on a one-half roepiah note

ORCHIDS ON MONEY

Reg S. Davis

Reprinted from *American Orchid Society Bulletin*, October, 1959

DURING the past few years a number of orchid plants and flowers have been represented on the postage stamps of several countries. There is only one instance that I know of, however, where an orchid is depicted on the paper currency of a country—and this is the illustration of what looks like *Spathoglottis plicata* which appears on the half roepiah note that was issued in 1948 by the government of what eventually was to become the Republic of Indonesia. This was during the period in which Indonesia was striving for its independence and, as will be noted, the value of the paper currency is expressed in two languages, Dutch (vijftig cent) and Indonesian (setengah roepiah). In the past year or so this paper note has been withdrawn from circulation by the government and another half roepiah note issued in its place.

Spathoglottis plicata is a ground orchid with an extensive distribution throughout Malaya, the islands of Indonesia, the Philippines and western portions of New Guinea. The plant has broad pleated leaves up to 3 feet long and 6 to 10 inches wide, a fact which is responsible for the specific name *plicata*, meaning "pleated." The flowers, which are about an inch across, are extremely variable, displaying various shades from white through pink, mauve, purple, rose and deep red purple. The plants usually grow in open areas at lower elevations along roadside embankments and washes. It is often grown throughout the area as a potted garden plant. The individual flowers are not hardy and consequently are of no value as cut flowers.

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DON'T LET THEM DIE

A soilless method for starting seeds

Glenn Viehmeyer

Condensed from *Flower & Garden Magazine*, February, 1959

THERE was a time when the damping off of seedlings was a problem. But no more! We no longer use soil for seed sowing.

Use of a sterile medium became necessary to guard against the loss of special hybrid seeds produced from our extensive plant breeding program at the North Platte Experiment Station. Whenever a seedling dies, a year is lost in our breeding work.

In our estimation even the best soil is second-rate material for growing seedlings. We never use it for special lots of seed, only for such toughies as tomato and cabbage. Our hybrid chrysanthemum, penstemon, petunia and rose seeds are never planted in soil; yet we are growing the best seedlings, the best cuttings, the best plants we have ever grown. We have almost eliminated seedling loss.

Several years ago the U. S. Department of Agriculture published a little booklet advocating the use of sphagnum moss as a medium for germinating seed. This was good! Sphagnum seems to contain a substance that inhibits damping off fungus and other organisms that kill seedlings. Get the seed to sprout and you have your plants with no fuss or worry. Rate of growth even can be controlled at your discretion by feeding the seedlings or cutting down on the amount of nutrient.

Sphagnum had much to recommend it but it also had one serious fault. The rootlets of seedlings formed such a sod that it was impossible to remove them without serious root injury. A medium that would not become soddy was needed.

Vermiculite partially met this need but it too had a fault. With repeated wetting and drying it tended to "slake down" and become waterlogged. Before the seedlings were ready for the garden the volume of vermiculite might have been reduced to one-half of its original volume and have lost the granular texture so important for good growth.

A new product made of lava rock, expanded by heat and called perlite, appeared on the market. This was stable, it did not slake, it was easily shaken from the rootlets of the seedlings, it had everything, except that it did not produce good seedlings in many cases. Grown in pure perlite, seedlings tended to be chlorotic, growth was slow and seedlings lacked substance.

After a period of trial, a combination of the three, sphagnum, perlite and vermiculite, was found to be an excellent medium for germinating seed and starting cuttings. Used at the rate of one part sphagnum and two parts each of perlite and vermiculite it was a medium that would not become "soddy," would not slake down and would shake from seedlings with minimum root injury.

This mixture has proved excellent for starting seeds of all kinds, from the dust-like seeds of begonia and African violet to the big seeds of nasturtium. Sphagnum increases the stability of the mixture and is necessary for the very fine-seeded species, but may be omitted when larger seeds are sown. For plants that produce big, husky seedlings, disturbance of the surface of the medium during watering is not serious, but to the tiny seedling of begonia and violet, it may be fatal.

Sphagnum can be obtained from almost any nursery firm and from garden

centers. Before grinding, it should be hand sorted to remove tree leaves, grass or other organic matter that might serve as focal points for fungus infection. The dry sphagnum is rubbed through a ¼-inch mesh screen to grind it. Ground sphagnum can be purchased but the cost is greater.

Both vermiculite and perlite can be purchased from the lumber yard at a cost lower than at a garden center if you are using a great deal of it. Ask for the plaster aggregate grade of perlite and the concrete aggregate grade of vermiculite. Horticultural grades of these products are now available at garden supply centers.

Fill your flats with the mixture, making sure that it is well packed in the corners and along the edges. After the flat has been filled and watered, plant the seed. You can either sow broadcast or plant in rows. Don't use too much seed. Crowded seedlings cannot develop into husky plants, and you will have to thin them. In the sterile mixture, seedling losses are far less than in soil. If seed germinates, seedlings will not be reduced in number by disease.

Seeds can be planted somewhat deeper than in soil, for this medium offers little resistance to the emerging seedlings. There is none of the hardening or crusting that occurs in soil. Larger seeds like aster, dianthus and delphinium can be planted ¼- to ⅜-inch deep. The tiny seeds of petunia and snapdragon may be ⅛-inch deep, while the dust-like seeds of begonia and African violet should be sown on the surface.

Water the tiny-seeded kinds with a very fine spray to avoid disturbing the surface of the growing medium. Better still, water from the bottom by setting the flat in a pan of water. One nice thing about our mixture is that you cannot overwater if there is proper drainage in the container. Excess water simply drains away.

Feeding is Necessary

Remember that you have planted the seed in a sterile medium that contains no plant food. You will have to furnish food by using a nutrient solution. Any of the soluble plant foods will serve as long as they are complete, that is, as long as they contain all the elements necessary for plant growth. We have used Ra-Pid-Gro, Hyponex, and Plant Marvel with good results. We prefer that the first feeding be at about one-half the strength recommended by the manufacturer. This can be applied at planting time or just as the first seedlings emerge. Subsequent feedings will be needed every week to

Part of a seed box of husky firethorn (*Pyracantha*) seedlings, growing in the sterile mixture

Author photo

These penstemon plants are from seeds started six weeks earlier in the soilless mixture. They appear healthy and have big root systems which will suffer little damage in transplanting

ten days until the seedlings are ready to transplant.

When seedlings reach the four- to six-leaf stage they should be transplanted to other flats and spaced 2 inches apart each way. The same sterile medium should be used as insurance against disease. When the weather warms up they are taken from the flats and transplanted to the garden where they make their first contact with the soil as big, husky plants with an extensive root system. Rootlets and root hairs are largely intact, and separate readily with many particles of the growing medium clinging to them. Transplanting shock is far less than with plants shaken from soil.

Try the mixture also as a rooting medium for cuttings. Results are excellent. You can space your cuttings 2 or 3 inches apart and not even transplant until time to put them out in the ground.

For better results TRY PRE-GERMINATION

William H. Wolff

Reprinted from *Horticulture,* January, 1959

GARDENERS sometimes fail to get a good stand of seedlings. In large measure this can be avoided by seed treatment and the pre-germination of seed before planting. A method I have used with seeds slow to germinate, such as carrot, celery, parsnip and regal and Formosa lilies, has been notably successful.

In late March, dust the dry seed with a good fungicide by placing it with a little of the powder in a bag and shaking. Next, mix the seed with several times its volume of moist sand and place it in a screw top Mason jar. Store the jar in a cool garage or cellar. After ten days, examine it to note germination. Lily seed is translucent so the embryo can be readily seen.

Just before the first rootlets emerge, remove the seed from the jar and plant it at once, or if the soil is not in condition, keep the seed in the container in a refrigerator and plant it on the first good day.

I cover the seeds with three-quarters of an inch of clean sand and vermiculite 50-50 by volume, then I firm the surface lightly and cover with burlap or salt hay. I remove the burlap or salt hay cover as soon as the little plants show above ground. Sand and vermiculite give me a seed row almost free of competing weeds.

NATURE'S COMMUNITY

David Pimentel

Reprinted from *The Cornell Plantations*, Autumn, 1959

NATURE'S secrets concerning an individual plant or animal lie not only within that plant or animal but also, and with equal importance, in the environment and community of which it is a part. No plant or animal can be separated from its environment, which is everything living and nonliving surrounding it. All the necessities for life are present in and are obtained from this environment.

Basically all forms of life depend upon soil, water, air and sun. Carbon, hydrogen, oxygen, and nitrogen plus a few minor elements provide the building material of life and the all-essential sun provides the energy to drive life's machinery. Plants alone have the ability to take raw materials from the earth for their construction. They also trap and store sunlight for use as a fuel for themselves and those that feed upon them. The surplus energy not used by plants for their own life activities is stored in plant tissue which in turn provides animals with all of their fuel and most of the building materials for their bodies.

Since animals are dependent upon plants, there is an optimum level at which animals feed. The economy of supply and demand in this case has to be carefully balanced. Excessive feeding by animals will eventually lead to the destruction of the plants, and the animals themselves will die of starvation. The same economy exists between animals acting as parasites and predators on other animals. If they destroy their quarry, they destroy their own food supply.

The delicate parts and their amazing organization which make up an organism are no more remarkable than the parts and organization which are necessary for the existence of nature's community. Each member of a community not only plays a role in the maintenance of itself, but of all the other members of the community. Plants act as the producers (manufacturers), animals as the consumers (customers), and micro-organisms as the decomposers (junk dealers). The groups are dependent one on another. In nature's community one group cannot survive without the proper function of the other groups. However, just as man can get along without a leg or arm so can a community adjust to the loss of a single species. In such an instance neither can be said to function normally.

Animals repay plants for their support in many ways. All plant-feeding animals aid in the breakdown of the used plant material into simple substances fit for re-use by other plants. Micro-organisms, bacteria and fungi, always present in the community of nature, are essential to the complete breakdown of the complex plant and animal bodies. This breakdown completes the cycle and conserves the essential substances necessary to the survival of the whole community because they are made available again.

There are countless examples of the amazing relationships between plants and animals in the community. The yucca cannot reproduce without the yucca-moth and this moth cannot survive without the yucca. The yucca flower is one not adapted to pollination or cross-pollination by the ordinary insect. It is pollinized only by one moth which has especially developed mouth parts for collecting balls of pollen. In these pollen balls the moth

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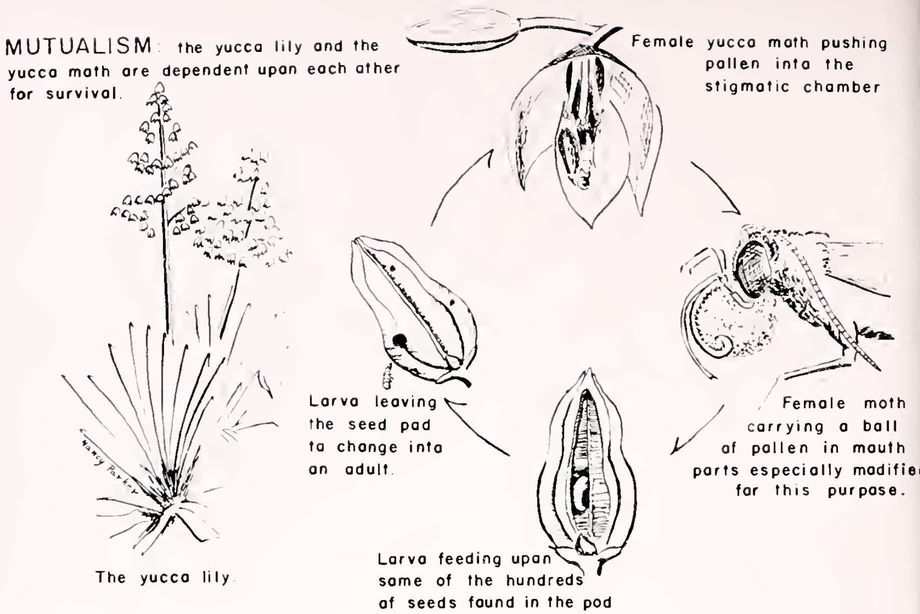


places her eggs and then places them on another flower. Thus in payment for pollination, the yucca provides room and board for the yucca-moth.

Other animals transport the plant progeny long distances for their establishments in new favorable habitats. The seeds of the burr-reed are specially designed for adherence to animal fur, and are carried great distances by this means. Many birds, such as the cardinal, feed on luscious berries. The berry-seeds are dropped here and there but some find favorable new areas for development.

The relationships so far described are simple and direct, but we know that the web of life is far more intricate. The abundance of our red fox is in part determined by the abundance of a particular insect disease microorganism. The red fox eats rabbits, which are nourished by cabbage-like plants, which are destroyed by the cabbage butterfly, which are attacked by a parasitic wasp, which itself is killed by a smaller parasitic wasp, which is susceptible to a disease producing microorganism. The existence and activities of each plant and animal which form a part of the community are affected by one and all.

Skeptics scoff at the idea of dynamic balance within nature's community. Some men consider that man is the all-conquering dominant power in the world. The fact that man has been powerless to prevent wars and famines offers rebuttal to his so-called superiority. But because man has the power to destroy some forms of life, should he eradicate all those species which appear to him to be pests? This is a question that should be as important to all as it is to the ecologist.

What is nature's balance? Simply, this is the equilibrium and stability which is inherent in, and therefore, a part of natural communities. We know that the countless cells of a single organism are fitted together to function as a whole. So it is with the varied individuals making up the community of nature. The balance of the parts has developed through centuries of time during which the members of the community have lived with each other and adjusted to each other's needs. This balance, typical of both the organism and community, can only come about when all parts are present and function-

ing properly. This is because each individual or part plays a vital role. New parts cannot be introduced or integrated parts removed without destroying the balanced economy in either organism or community.

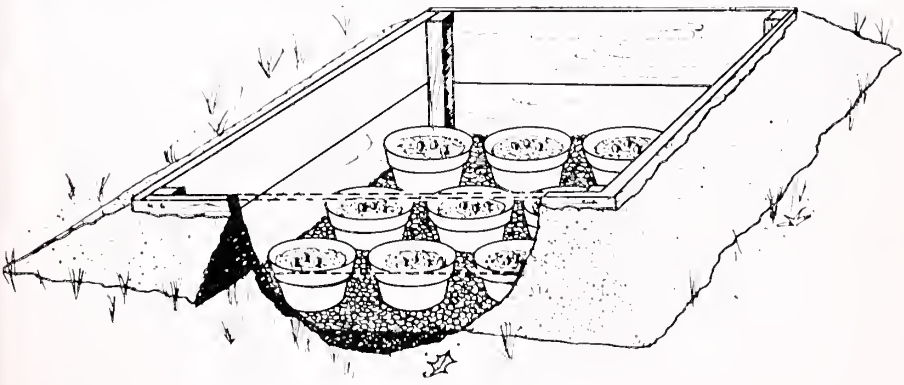
We are all too familiar with the havoc wrought by the addition of a few cancer cells to the community of normal cells. Prominent in the news these days is the woodland destruction resulting from the introduction of European gypsy moth to our American forests.

Diversity of parts which is typical of natural communities functions to give it stability just as diversity in financial investment gives stability to the program. When parts of a community are removed and the structure is changed from one of complexity to one of relative simplicity, nature's balance is destroyed. Insect pest outbreaks are known to occur most often on cultivated land. There man, by cultivating, not only eliminates much of the varied natural planting but then plants one variety in pure stand. In restricting the plant life, the number of species in the animal community is reduced because the food plants for many species are eliminated. Poorly planned control programs for crop and forest pests often kill innocent, and in many cases beneficial animals, as well as the real pest. To mention one of many instances, outbreaks of mites have occurred in apple orchards following the application of DDT which was used to kill the codling moth. It did that but also destroyed beneficial predators which allowed the mites to increase to destructive numbers.

From the selfish viewpoint of man, the business of eradicating species and simplifying nature's community is one of danger to man's existence. The inexperienced does not tamper with the mechanism of a fine watch by thrusting a pin into it. Nature's community is even more complex. Ecologists and naturalists alike must continue to work toward a more thorough understanding and appreciation of nature's existing balance. As the numbers of man continue to increase in the world, means must be found for preserving nature's balance as forests are cut, prairies are plowed, streams are polluted, and pesticides applied. Survival in the future depends to a large extent on the successful co-existence of man and nature.

An Easy-to-Make Bulb Storage Frame

Sink a four-sided box, having sides made of two widths of 10-inch boards with an overall depth of 20 inches, so that the box is 10 inches below soil level. Then mound up soil against the outside of the box to the top. This will insulate the frame against the cold. Potted hardy bulbs, which are to be stored in this frame during fall and early winter for prerooting before forcing indoors, should be set on a layer of gravel in the bottom, then covered with sand or peat, and finally a thick layer of straw or leaves.—Jerome A. Eaton. *Bulletin* of The Horticultural Society of New York



WHY SHADE TREES DIE ALONG CITY STREETS

P. P. Pirone

Condensed from *The Garden Journal*, November-December, 1959

SHADE trees planted along city streets never die of old age. Nor do they live as long as their country cousins. The reasons for this are many and varied.

City trees live in an unnatural environment. Their roots are restricted by cement and asphalt pavements which greatly reduce the supply of available air and water. In many cities the open soil beneath a tree measures only about 16 square feet. Through this limited area must pass most of the air, water, and plant food the tree will absorb during its lifetime.

Other unfavorable factors to which most city trees are exposed include a polluted atmosphere, extremely high reflected heat, and a low content of organic matter in the soil.

Studies in progress since July 1956 have revealed that a number of other factors or agents cause the premature death of shade trees. The investigations involve a detailed study of 330 dead or dying shade trees planted along streets in New York City and northern New Jersey.

I examined every one of these trees on location at least once; some as many as three times. Some of the inspections took only a few moments. Others included the collecting of bark and sapwood specimens from the trunk, roots, or branches, and took as long as an hour.

Most of the dead trees had died within the year. But some had been dead for at least two years. Diagnoses in these latter cases were difficult or impossible to make.

One surprising revelation was that Norway maple (*Acer platanoides*) was the most frequent casualty. Of the 330 trees studied, 275 were Norway maples. One reason may be that this species was planted more extensively than the others. Nevertheless, the present investigation suggests that this species is more subject to fungus parasites and other ailments than are other kinds of trees.

Most Common Fungi

The fungus most often associated with dead or dying Norway maples was *Ganoderma lucidum*. Over 22 per cent harbored this fungus.

Because such a high per cent of trees was involved, young Norway maples (three years old) were inoculated with pure cultures of the fungus. This resulted in infection and death of the inoculated trees, proving that the *Ganoderma* fungus is capable of parasitizing Norway maples.

Verticillium albo-atrum was the next most common fungus, infecting 12.7 per cent of the trees. The shoestring root rot fungus *Armillaria mellea* was the third most prevalent species.

A few trees were found to harbor more than one parasitic fungus. For example, *Verticillium* and *Ganoderma*, or *Verticillium* and *Armillaria*, were sometimes isolated from the same tree. Species of *Phytophthora*, *Sphaeropsis*, and *Penicillium* were associated with a few of the diseased Norway maples.

Other Agents

Other causes of the premature death of Norway maples were so-called mechanical injuries, comprising 7.2 per cent of the total. Included in this group were girdling roots, damage by vehicles and malicious injury. I found several trees,

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The Dutch elm disease fungus *Ceratocystis ulmi* causes brownish discoloration of the sapwood, visible in the cut sections of twigs above

Greenish discoloration in the branches caused by the fungus *Verticillium albo-atrum* is rather rare. This symptom is more common in the roots and base of the trunk

The fungus *Phytophthora cinnamomi* attacks the inner bark and sapwood of Norway maples. The bark has been cut away to show diseased area

The bark of this Norway maple has been removed to expose the white wefts of the fungus *Armillaria mellea*

for example, that had been girdled with an ax just below the level of the soil, which had then been replaced to conceal the girdled area.

Four per cent of the trees were killed by chemical substances. Included in this category were turpentine, dry-cleaning fluids, crank-case oil, and improperly applied tree-banding materials used to trap cankerworm moths.

Girdling roots occasionally strangle trees growing along city streets

Injury by an automobile caused this severe injury to the bark

An "excellent" paving job helped to contribute to the death of this Norway maple

Douglas Eastman

Fires are a contributing factor in the premature death of some street trees

Poor drainage and winter injury accounted for very small percentages of the losses.

Thirty-seven trees, or 13.1 per cent, died from unknown causes. Among the probable causes of death were frequent visitations by male dogs and the use of rock salt. The former causes so-called "dog cankers" which kill the bark at the base of the tree. Placing a metal collar around the base of a tree is not enough to prevent such damage because the toxic secretions enter the soil anyway and thus kill the roots. The soil around one tree frequently visited by male dogs was found to contain 900 parts per million of soluble salts—more than four times the maximum tolerance of some trees.

Rock salt applied by home owners or apartment house superintendents to melt snow or to prevent ice formation on sidewalks, or that applied along city streets to keep vehicles from skidding, also kills trees. The salty water is frequently swept

into the open soil area or is splashed into it by passing vehicles.

Observations on Other Tree Species

Among other maple species included in this investigation were nine red (*A. rubrum*), eight soft (*A. dasycarpum*), six sugar (*A. saccharum*), and one sycamore (*A. pseudoplatanus*). These were afflicted by the same fungi and other agents that affected Norway maples.

Of 12 London planes (*Platanus acerifolia*) studied, six were found to have died from the fungus *Ceratocystis fimbriata* f. *platani*. Three others were being or had been killed by the fungus *Botryosphaeria ribis*. In nearly every instance leaf-fires beneath the trees seemed to have been associated with the infections. Injury of this type should decrease sharply in New York City, at least, because of the recent restrictions placed on burning of materials by the Department of Air Pollution Control.

Five of eight American elms studied died from Dutch elm disease caused by the fungus *Ceratocystis ulmi*. This disease, by the way, is presently causing more havoc to American elms in the vicinity of New York City than in any of the 26 years during which I have worked with it.

Three pin oaks, two red oaks, two catalpas, two basswoods, one white birch, and one sweet cherry comprised the remaining trees studied. These died from a wide variety of causes, including fungus attack, mechanical injury, or excessively deep planting.

Nine of the 55 trees other than Norway maples died of unknown causes. As with some of the Norway maples, diagnoses were impossible because these trees had been dead for two or more years.

How to Attract Honey Bees in New Hampshire!

Dr. Francis O. Holmes, a plant disease specialist at the Rockefeller Institute, has many personal hobby interests. One of these is his New Hampshire farm, where he has noticed that honey bees shy away from many of the plants that are well-known nectar producers in other areas. For example, his red raspberry bushes were in full flower last summer, but no honey bees came near. Whatever pollination there was, was done by bumble bees and miscellaneous other insects. Dr. Holmes suspected that this might be indirectly due to New Hampshire's boron deficient soils, so he dusted a little powdered borax around and on some of his raspberry bushes. Within two days, honey bees were busy on the flowers of the bushes that had been thus treated, though they continued to ignore the untreated plants. Other experimental work, on alsike clover, supports the view that boron is necessary for satisfactory nectar secretion. Thus, any area with soils that are known to be boron deficient, should have fertilizer containing boron if the honey bees are expected to do their work. Details of these observations appear on p. 102 and 103 of the March 1960 issue of the American Bee Journal. Meanwhile, if you live in an area where the soil is boron deficient and if honey bees seem uninterested in your blossoms, try dusting a very little ordinary borax on the soil under some of the bushes or trees.

CURE OF ROSE MOSAIC DISEASE—BY HEAT

DR. F. O. HOLMES of the Rockefeller Institute has for some years been interested in the mosaic disease of roses. This virus disease differs in intensity of mottling, depending on the rose variety as well as on the virulence of the virus strain.

Dr. Holmes found in the Cranford Memorial Rose Garden, at the Brooklyn Botanic Garden, a strikingly mottled plant of 'Gruss an Teplitz' from which he made a series of cuttings, all of which showed the same intensity of mottling—this was in August, 1956. He rooted the cuttings, and as soon as the young plants were growing satisfactorily, he "hardened them off." When the growth was no longer soft, he placed the plants in a lighted incubator and held the temperature high enough to maintain a soil temperature of about 34° to 36° C. (93° to 97° F.). The plants were held at this temperature for intervals of from one to ten weeks. When removed to the greenhouse, those heated one to three weeks remained mottled, *i.e.*, the disease was still active. Those heated four to ten weeks produced unmottled new foliage. In short, the virus disease was no longer active.

Dr. Holmes is not willing to commit himself beyond this just now. He has arranged for a "cured" plant to be grown among the diseased specimens, for further observations on the spread of the disease. Past studies have indicated that the disease does not ordinarily spread in nature, or in garden culture. Present evidence suggests that it is spread only by grafting.* Dr. Holmes points out that there are probably many strains of the rose mosaic virus, some of which are very mild. Plants with a mild disease would be immune to the more virulent form of the virus. He ventures the suggestion that many, perhaps most roses in cultivation are infected with the mild form of the disease, which doubtless obscures recognition of the disease generally.

*Brierley, P. and Smith, F. F. Mosaic and streak diseases of rose. Jour. Agr. Res. 61: 625-660. 1940.

Leaf of the 'Grus an Teplitz' rose, disfigured from mosaic disease

A leaf of the same clone cured by a six-week heat treatment *Holmes photos*

INSECTICIDES AND BIRDS*

George J. Wallace

In five years, robins on a 185-acre tract were almost entirely eliminated by intensive DDT spraying

Condensed from *Audubon Magazine*, January-February, 1959

All of us realize the critical need for more complete data on the effects of insecticides on birds, but we also realize the urgency of making whatever data we have immediately available. Hence, at the risk of some possibly premature conclusions I am glad to present some of the factual evidence I have. For we need these data *now*. A few years hence, when information is more complete, will be too late. We are just beginning to learn of things we needed to know ten years ago.

These initial data deal mainly with a carefully measured population decline of robins over a five-year period on the Michigan State University campus at East Lansing, coincident with an intensive spraying program to control elm bark beetles (which transmit Dutch elm disease), and for mosquito control. East Lansing, including the Michigan State University campus, had aerial applications at the rate of a pound per acre of DDT for mosquitos over the entire community in 1955, 1956, 1958. The Dutch elm treatments started a year earlier and have been continued periodically ever since. During this time, quite by accident and not design, John Mehner, a graduate student, was studying robin populations in two unsprayed residential areas in Pittsburgh, Pennsylvania, and in two sprayed areas in East Lansing, including particularly the five-acre plot formerly comprising the Michigan State University Horticultural Gardens. His data on the population decline in East Lansing from 1954 through 1957, supplemented by my observations in 1958, tell a dramatic and a disturbing story.

We first noticed robins dying on the campus in the spring of 1955, the year following the start of the local Dutch elm disease program. The die-off of robins continued each spring, on a scale sufficient to attract the unsolicited attention of the staff and students of Michigan State University, until by the summer of 1958, the elimination of robins from the main campus and some parts of East Lansing was virtually complete. At first I attributed the deaths to some disease affecting the nervous system, but it soon became evident that, in spite of the assurances of the insecticide people that their sprays were "harmless to birds," the robins were really dying of insecticidal poisoning; they invariably exhibited the well-known symptoms of loss of balance, followed by tremors, convulsions, and death. It was also soon apparent that earthworms might be the toxic agents. Among other things, campus earthworms inadvertently fed to crayfish in a research project brought death to all of the crayfish, and also brought on tremoring in a caged snake. The full details of just how this cycle operates in robins, however, was largely speculation until the publication of Dr. Barker's thorough analyses of leaves, leaf litter, soil, earthworms, and

* A talk presented by Dr. Wallace before the 54th Annual Convention of the National Audubon Society, November 10, 1958.

robins in Illinois,** which clarified the confused situation.

Briefly, for those not familiar with this cycle, Dr. Barker's studies show that earthworms accumulate and concentrate DDT in their bodies by feeding on leaf litter from sprayed trees. Earthworms analyzed had deposits of DDT throughout the digestive tract, especially in the crop and gizzard, but also in all parts of the body wall, the dorsal blood vessel, and even in the ventral nerve. When robins eat the earthworms, chiefly in the spring following the year of spraying—since sprayed foliage is not available to the earthworms until fall and the infected earthworms not abundantly available to robins until the following spring—they in turn accumulate deposits in their bodies. One robin completely analyzed had 14 organs and tissues infected, with the greatest concentration lodged in the testes and intestines. Eventually the DDT reaches the brain cells (35 of 40 robin brains analyzed had DDT), causing locomotor paralysis and convulsions, followed by death within a few hours. I have never known a robin to recover after tremoring sets in, and Walter Nickell, at the Cranbrook Institute of Science, Bloomfield Hills, Michigan, where dying specimens were received from the Detroit area, had nearly 200 afflicted birds "die on his hands" without saving a single one.

Our figures on the population decline on the campus of Michigan State University during the five-year period of study are dramatic, conclusive, and alarming. In 1954 the Horticultural Gardens—not optimum, or most favorable, robin habitat—had five pairs (five nests) on approximately five acres. Some campus areas had higher densities, but even using the lower figure of one pair per acre gives a total of 185 pairs, or 370 adults, on the 185-acre North Campus. On this same area in 1957 Dr. Mehner found only 15 adult robins in three surveys in late June. In 1958 my June to August records, including one fairly thorough survey each month, totaled only three adults and one fully-winged bird of the year. (Ten robins seen crossing a corner of the campus in their early morning dispersal from an off-campus night roost on August 7 were not considered campus birds.)

Figures on nesting failures are even more startling. In 1954, Mehner's five study-nests in the Horticultural Gardens were all successful in producing young. In 1957, the two remaining nests were unsuccessful, so an intensive search for nests was made over the entire North Campus. Of the six nests found, five produced *no* young and the fate of the sixth was not determined. On June 21, and again on June 22 and on June 24, Dr. Mehner searched the entire North Campus for young robins but found only one—this on an area that in 1954, on the basis of known population of adults and their nesting success, would have had at least 370 young. Detailed studies were not carried out in 1958, but at no time during the spring or summer did I see a fledgling robin anywhere on the main campus, and so far have failed to find anyone else who has seen one there.

The distribution of robins in other parts of East Lansing is very spotty—few or none in some areas, but apparently fairly numerous in some parts of the city which had been sprayed only for mosquitoes and not to control the spread of Dutch elm disease.* Understandably, these "fringe" robins, including a dwindling late summer roost that has been in existence for many years, gave me embarrassing moments—as long as a few robins can be found anywhere in the community I am considered an alarmist by people who

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**See the *Journal of Wildlife Management*, July 1958 issue, Vol. 22, No. 3, pp. 209-274.—The Editor.

*The DDT spray is used on elms to kill bark beetles which carry the fungi of the Dutch elm disease and spread it among previously unaffected trees.—The Editor.

are not aware of the facts. The robin, like the passenger pigeon, would have to be extinct for about ten years before some of these people would admit that it was gone.

Incomplete data, still being assembled, reveal a similar situation in other sprayed communities, particularly those with an intensive Dutch elm disease program, *and little or no decline in unsprayed communities.* Dr. Mehner's Pittsburgh study areas showed no decline in either nesting pairs or nesting success over this same four-year period. But some of the heavily sprayed suburbs of Detroit, Milwaukee, and Chicago, according to incomplete but creditable reports I have, are virtually without any robins. Computed either per tree or per acre, the several million sprayed elms in this country (figure from U.S. Fish and Wildlife Service, Patuxent Research Refuge, Laurel, Maryland) indicate a loss of millions of robins.

Obviously this same cycle, or a similar cycle, must apply to all ground-feeding birds that eat earthworms, or perhaps other affected soil organisms, but only for the robin are the full details known. Associated with the dead robins, at East Lansing and in Detroit, however, have been smaller numbers of flickers, blue jays, thrashers, catbirds, starlings, house sparrows, grackles, and cowbirds, all primarily ground feeders that may or may not get their insecticidal potion from earthworms. Examples of all these species have been observed dying of typical insecticide-poisoning symptoms, and specimens analyzed in other projects have been found positive for the insecticide involved.

Tree-top feeders (leaf gleaners) are affected in an entirely different way, by insect shortages, or by eating of poisoned insects in lethal quantities, or in sublethal quantities causing sterility in the birds in subsequent years. I have no data from dead or dying leaf-gleaning birds at East Lansing, but all of the insectivorous species formerly associated with the campus elms have disappeared. Walter Nickell, recipient of the several hundred specimens turned in to the Cranbrook Institute of Science from the Detroit sprayings, writes that nearly all species of warblers present in the area at that time were represented in the heavy kill of birds. Curiously too, some predatory birds— a red-tailed hawk and several screech owls—must have obtained their fatal doses indirectly from their bird prey.

A common grackle, robin and white-breasted nuthatch (left to right) found dying of typical insecticidal poisoning symptoms

Photo from Information Services, MSU

We have even less data on birds that forage on the trunks and branches of trees (12 campus species), but some of these have been severely redu ed in numbers. No black-capped chickadees or white-breasted nuthatches appeared at my home feeding station last winter for the first time in many years, and several other feeding station operators have reported the same experience. Of three nuthatches I have seen since, one was found dead, another found dying of typical DDT symptoms, a third, pathetically, was feeding on an elm. It seems likely that the dormant sprays applied to the elms, particularly in the fall, may be fatal to woodpeckers, titmice, chickadees, nuthatches, and creepers.

Altogether, according to my local records which cover a span of 16 years, 49 of the 77 species that were formerly summer residents in East Lansing have disappeared entirely or have definitely decreased in numbers. Some of these losses are due primarily to habitat changes; a few others are of straggler species whose absence in recent years may have no significance, but the majority are insectivorous birds that are definitely known to have suffered from insecticides. In a cursory, incomplete survey of published literature, and from some correspondence, I find records for more than 140 species of birds believed to have died from pesticides, and this is just a beginning; included are 27 cases of complete or nearly complete reproductive failure due to sterility or other causes.

This account leaves some doubt as to comparative effects of a program to control the spread of Dutch elm disease, versus the lighter but more widespread applications for mosquitoes. At East Lansing, programs of both types have been intermingled so long that it is hardly possible to separate the effects. In general, however, it appears from this and other studies that one or two light applications for mosquitoes produce little or no *immediately noticeable* reductions in bird populations, but that a three or four year program produces precipitous declines in most insectivorous species. An intensive Dutch elm disease program is much more severe over limited areas but affects fewer species; locally it has resulted in complete or nearly complete elimination of all species closely associated with elms, including the birds that are leaf gleaners, bark foragers, and ground feeders. Our insectivorous birds are facing the greatest man-made threat they have ever experienced, and one of the inevitable results is their replacement by "nuisance" birds (starlings, house sparrows, pigeons, grackles, etc.) which are not dependent on insects but can survive on the waste products of man's activities.

Up to this point I have tried to present largely factual data. In conclusion I wish to express three somewhat more philosophical views resulting from my deliberations on these problems:

(1) The current widespread and ever expanding pesticide program poses the greatest threat that animal life in North America has ever faced—worse than deforestation, worse than market hunting and illegal shooting, worse than drainage, drought, or oil pollution, and possibly worse than all of these decimating factors combined.

(2) The present ill-conceived and ineptly executive fire-ant "eradication" program will go down in history as one of the worst biological blunders that man has ever made.

(3) If this and other pest-eradication programs are carried out as now projected, we shall have been witnesses, within a single decade, to a greater extermination of animal life than in all the previous years of man's history on earth, if not since glaciation profoundly altered the life of the whole northern hemisphere.

Author's Note: Possibly this article could be a little misleading to home owners and gardeners who spray their plants and flowers to control pests. Actually, I think the greatest damage to birds is done in large-scale control operations rather than in local applications, as for garden plants. In any case, people must be careful what they use for pest control, and how they use it.

TO KNOW THE NAME OF A PLANT

R. D. Burroughs

Condensed from *Nature Magazine*, October, 1959

"TO know the name of a plant is to have a key to its literature," said Dr. Joseph T. Rothrock, in one of his lectures on wild flowers many years ago.

That plants have a literature aside from technical accounts of their structure and taxonomy still is, I think, a new idea to a great many people. I will never forget the day on which I first heard the story of the naming of *Achillea millefolium*. The occasion was a botany field trip. Our professor paused, and reached for a weed that I knew only by its common name of "yarrow." He told us the story of Achilles, and how he used this herb in treating the wounds of Telephus. Theophrastus, pupil of Aristotle, and the greatest of the ancient Greek botanists, called the plant *Achillea* in memory of Achilles. It was only a weed of questionable beauty and an acrid odor, but it was dignified by Greek tradition and bore the name of a hero-god.

Many other plants named by the ancient botanists bear names suggested by Greek mythology. The orchid of your lady's corsage was named for Orchis, who was born to a nymph and a satyr, and who was reputed to be an individual of uncontrolled passion. According to the legend he became intoxicated at one of Bacchus' festivals, and attacked a priestess. Being apprehended in this act, he was set upon by the company and destroyed. Orchis' father beseeched the gods to restore him to life and health; but, instead, they reassembled him in the form of an exquisite flower whose beauty might serve to appease the gods and delight the earthlings.

Much of the literature relating to plant names is widely scattered, but some of it has been made available to us in the delightful books of Charles Francis Saunders, and other literary naturalists. I also can recommend the source books of plant literature; the writings of Aristotle, Theophrastus, Homer, and Pliny; the "herbals" of the Renaissance botanists; and, for stories of many of the native American plants, the journals of our pioneer naturalists and explorers.

The name of Dr. John Torrey, who identified many of the plants collected by John C. Fremont during his western expeditions, is perpetuated in the Torrey pine (*Pinus torreyana*), a species naturally confined to one small area on the Pacific Coast near San Diego, California

A knowledge of the history and tradition of a plant adds much to one's pleasure upon encountering it. For example, in the summer of 1933, in the woods about Deer Lake in northern Minnesota, I found my first specimens of a beautiful little creeping plant called the twinflower. The name is fitting because the pink, bell-shaped flowers always are borne in pairs on long, slender flower stalks. The scientific name of the plant is *Linnaea borealis*, and thereupon hangs another story. The plant was discovered first in Lapland, in 1735, by the great Swedish scholar and botanist Carolus Linnaeus. He was so delighted with this beautiful little boreal plant that he wanted it to bear his name; but modesty forbade him naming a plant after himself, so he turned it over to one of his pupils with the suggestion that it might make a fitting memorial to some great botanist. Whereupon the young man arose to the occasion and named the plant *Linnaea borealis*!

But not all plant names suggest amusing incidents of this kind. Many of them are truly fitting memorials to men who have lived life to its fullest. Not all of them were botanists by profession; there were doctors, ministers, tradesmen, soldiers, and explorers who loved plants and God's outdoors.

One of these was John C. Fremont. Most of us think of Fremont as a military leader and explorer, but there was another side to his nature. Fremont loved plants, and on his five expeditions to the West, he never failed to return with bundles of pressed specimens, many of which were new to science. Most of these collections were turned over to Dr. John Torrey for identification. One bundle contained a flowering shrub of extraordinary beauty and botanic interest, because it proved to be an entirely new genus. Dr. Torrey named it *Fremontia californica*, in honor of the great pathfinder.

Dr. Torrey himself was a stay-at-home. He had a job teaching chemistry in the New York Medical College, and later he was connected with a branch of the United States Assay Office. During his spare time, he did the great work in botany for which he is now famous. It was late in his life before he had an opportunity to see alive many of the plants that he had classified in New York City forty years before. His name is perpetuated in a number of western plants, chief of which is the Torrey pine, a species situated in a small grove near San Diego, California, and found nowhere else in the world as a natural growth.

Many plants that grow in the northwestern states bring to mind the names of Lewis and Clark. While making their historic journey across the continent in

U. S. Forest Service

The Douglas fir (*Pseudotsuga taxifolia*) of the Pacific Northwest honors David Douglas, Scotch gardener who was sent to America to collect plants and seeds for English gardens

1804-1806, by way of the Missouri and Columbia rivers, they collected and described many plants; but only 150 specimens, all collected west of the Rocky Mountains, were brought back safely. Those collected east of the Rockies on the outward journey were lost in transit. In 1814, the collection was turned over to Fredrick Pursh, who examined the plants and named the new species. Among them was a strange plant whose roots seemed to show signs of life, although it had been collected and pressed by Lewis six years earlier. Pursh planted the roots, and much to his amazement they revived and grew. To honor Captain Lewis he named the plant *Lewisia rediviva,* meaning "Lewis' plant that lives again." This plant is commonly known today as "bitterroot," for which the Bitterroot Mountains and Valley of Montana are named. It also has the honor of being the state flower of Montana.

Pursh did not neglect to grant his honors equitably for, among the plants collected while the explorers were encamped on the Kooskooskie River in Idaho, was one of singular structure and beauty that he named *Clarkia pulchella,* meaning, "Clark's plant, the beautiful."

On June 1, 1806, Lewis wrote concerning *C. pulchella* in his diary: "I met with a singular plant today in blume of which I preserved a specimene; it grows on the steep sides of the fertile hills near this place . . ." Then, after writing a long, careful description of the plant, replete with technical details concerning its structure, he concluded with the statement: "I regret very much that the seed of this plant are not yet ripe and it is probable will not be so during my residence in this neighborhood."

And so this beautiful pink flower, with its four 3-lobed petals, remained unknown, except for the pressed specimen in the Lewis and Clark collection, until 1830. Then David Douglas rediscovered it in Oregon and sent the seeds home to England, where it soon became a favorite among English gardeners.

Have you ever seen the bear-grass growing in the mountain meadows, or gazed across the valleys of Multnomah's kingdom, blue with camas? If you thrill to alpine scenes and love the quiet solitude of mountain meadows, you will have a goal; you will not rest until you tread Elysian fields all creamy-white with bear-grass plumes, or blue as sky with hyacinths. And, as you look, you may recall the place these plants have held in history.

Bear-grass, or "squaw-grass" as it is sometimes called, reminds us that Indians used its leaves in weaving baskets, hats, and even cooking vessels. Captain Lewis wrote that "they (the Clatsops) wear a hat of a conic figure without a brim confined on the head by means of a string

M. R. Clare

The American Indians of the Northwest used the leaves of the plant known as bear-grass, or squaw-grass, in weaving baskets and hats.

which passes under the chin and is attached to the two opposite sides of a secondary rim within the hat," and that "these hats are made of the bark of cedar and bear-grass wrought with the fingers so closely that it casts the rain most effectively . . ." He also mentioned that both hats and baskets were used for carrying water, and for cooking vegetables. I thought the latter use improbable, until I learned that they accomplished it by dropping heated stones into the water, bringing it to the boiling point.

The camas, or camassia, which the Indians called "quamash," has helped to shape the history of the West. It was perhaps more widely used for human food than any other western plant. Explorers, trappers, pioneers, and all the western Indian tribes depended on it for subsistence when game and fish were scarce, or planted crops had failed.

Before the white man claimed the West with ax and plow, the camas fields were tribal property. Boundaries were disputed and wars were waged by rival tribes. Chief Joseph of the Nez Perce led his braves in final desperate combat to save his camas lands from white men moving in to settle Oregon.

John Bartram was among the earliest of the American botanists to gain renown in Europe. It is said that he was an uneducated Quaker farmer at the age of thirty, or perhaps thirty-five, with no technical knowledge of plants. But he had great love for them, as well as the courage to buy a text book of botany written in Latin, and a Latin grammar, and to educate himself in a difficult subject.

Then began many years devoted to travel and study, during which time he made numerous collecting trips through the wilderness areas of Virginia, Georgia and the Carolinas. Through his friend, Peter Collison, he collected seeds and plants for the lords of England.

Among the plants he discovered were the shooting star, the trillium, the showy lady's-slipper, the American lotus, and the sensitive pea. But his most notable discovery was the tree, *Franklinia alatamaha*. In the autumn of 1765, while collecting near the Altamaha River in Georgia, he came upon a strange tree that was in flower. The blossoms were like those of the camellias and the tea plants of Asia. In 1773, Bartram brought seeds and cuttings of this tree out of the woods and planted them in his garden near Philadelphia. In 1790, Dr. Moses Marshall also reported finding this species, but no one has ever again found it growing in the wild. Specimens derived from John Bartram's original cuttings can be seen, however, in gardens in the vicinity of Philadelphia.

What was the exact location of Bartram's original tree? How did it happen to be growing in the wilderness of Georgia? Were there many of these trees in the same or neighboring localities? If so, what became of them? These questions have never been answered. *Franklinia*, named for Benjamin Franklin, remains one of the great mysteries of American botany.

Devereux Butcher

The whorled pogonia at left is a member of the orchid family, named for Orchis of Greek mythology, child of a nymph and a satyr

ALASKA PLANT PIONEERING IN A RUGGED CLIME

Sally Carrighar

Reprinted from *The New York Times*, July 19, 1959

ALTHOUGH winter temperatures may drop to 70 below zero and much of the soil is frozen permanently into bedrock, a popular hobby in Alaska is gardening. It is more than a hobby. With imported foods priced to include the freight from Seattle, Washington, many families have found a garden an effective way to defeat Alaska's high cost of living.

An Alaskan flower garden can be a special delight, for it often rewards its owner with size and color of blooms never seen in a warmer climate. Fairbanks delphiniums, for example, often are taller than their growers. A recent fair in that city included, in addition to 26 kinds of vegetables, cut flowers of asters, calendulas, marigolds, pansies, petunias, poppies, salpiglossis, scabiosa, schizanthus, sweet peas, stock, zinnias, dahlias, delphiniums, gladiolus and roses.

Credit and Debit

Lawns, especially those planted to Kentucky bluegrass and well-fertilized, are comparatively easy to grow in some parts of the state. There are few plant pests and diseases. But the pioneer gardener faces some challenging problems—an extremely short growing season, cold soil in most parts of the state, no soil in some parts like Nome and almost continuous daylight hours in season.

The problems vary greatly in a land that stretches 2,400 miles from east to west and 1,000 miles from north to south. In southerly Juneau, for example, the annual growing season lasts 183 days. Fairbanks, in a latitude nearly 500 miles to the north, is fortunate when it has 100 days between killing frosts. Yet geography does not explain everything, for rainy Juneau averages only four hours of sunshine a day in summer, while less rainy Fairbanks can count on nine hours.

Cold soil rules out gardening in the greater part of Alaska. The solid permafrost thaws only a few inches in summer, although it may thaw farther down after it has been stripped and drained.

Even if the subsoil is not actually frozen, it still retains so much cold between winters that trees in the interior have no tap roots, only lateral roots, and root vegetables do not grow deep. They sometimes even grow horizontally. Cold in the soil inhibits bacterial action, too, so that organic elements are slow to break down.

Soil and Water

In composition the soils are of different types, but many are loam sands or silt that respond well to fertilization. In prolonged dry spells watering is important, since the fine silts are apt to blow away. Well water from the lower strata needs to be warmed by the sun in barrels before it can be used on a garden.

An unusual boon is the hot mineral springs that warm the soil in several local areas. They extend east and west in a belt close to the Arctic Circle, and enterprising gardeners have grown luxuriant plants with the spring water.

There is no permafrost under sandspits and river bars, and Eskimos have established truck gardens on some of them, using fish waste as fertilizer. One of their techniques is to spread sand over the snow to hasten thawing in spring. Eskimos are very sensitive to nature's beauty and grow the white man's flowers with touching enthusiasm.

Photo courtesy Robert Sliter

Picture taken at Fort Yukon on the Yukon River just north of the Arctic Circle. The little house on legs is a typically Alaskan structure called a cache, and is used for storing meat and other foods, as well as equipment. Vegetable garden in foreground.

Most northern gardeners find that a profitable vegetable crop requires a greenhouse start prior to the growing season. Home greenhouses abound; some families simply add them as an extra room when building. They are made of materials which are expensive in Alaska, and they must be heated for several weeks. Yet greenhouses have paid for themselves in one season in cash value of produce started.

Some vegetables thrive only if grown under glass all summer. These include tomatoes, lima beans, green peppers and, in most areas, snap beans. Corn has not yet been grown successfully in Alaska, although the agricultural experiment stations are working to develop hardier strains.

Besides cold, heat can be a problem, too. Summer temperatures occasionally are extreme: up to 91 degrees in the Matanuska Valley, Alaska's largest farming area, and 98 degrees in Fairbanks' Tanana Valley, where agriculture is making fast strides. The usual summer day, however bright, is cool with an average spread of 45 to 66 degrees at Matanuska, 49 to 68 at Fairbanks.

Down in the Valley

On a clear day the sun may beat down for twenty-one hours on the Tanana Valley, and the almost continuous stimulation has an amazing effect on plant growth. Actually, most plants take a short rest after midnight despite bright sun, and some, like soy beans, spinach and geraniums, do not do well in the North because they require more darkness.

But plants that can stand the light grow with startling speed to a startling size. These are some of the records produced in Alaska: a 42 pound cabbage, a 63 pound pumpkin, a 3 pound potato, a 6 pound head of lettuce and a 6 pound stalk of celery 3 feet high.

Size alone is not as important as food value, and scientific analyses seem to indicate that northern plants store up an ex-

cess of nutritional value. Roughage for cattle, for example, has three times the protein content as the same type of roughage grown farther south.

Wild rose hips, which are rich in vitamin C, yield an increasing amount the farther north they are found. Alaska housewives gather the hips and preserve them for winter use. (The Alaskan Agricultural Extension Service distributes a free booklet of recipes.) The flavor of vegetables also seems to improve in the higher latitudes.

'Way Up North

Nome, in the north, is built on crushed rock over permafrost and virtually no plants can be cultivated outdoors. The residents, however, raise under glass a wide variety of vegetables and flowers like gloxinias, tuberous begonias, African violets and roses. Indoor gardeners have been known to pay air freight on soil shipped in. I did myself, when I lived in Nome.

The city carries on in the spirit of more prosperous days when the gold rush had given its people handfuls of gold to fling about. At a commercial greenhouse in that Arctic climate roses then sold for $12 each. The price was for future delivery, before any color showed in the buds, and with no refunds if the blossoms failed to develop.

Alaskans don't need to pay $144 a dozen for roses now. They pay with effort, but I have never heard complaints, only glowing expressions of satisfaction. Every seed put in the ground is a challenge, but challenges are what the pioneer temperament likes. Successful gardening in Alaska, like anywhere else, requires study, care and some expense. Plus a philosophical attitude—for that unexpected frost in July.

SECTION OF PHIPPS ESTATE BECOMES A PUBLIC GARDEN

OLD Westbury Gardens, one of the country's famous private gardens, located in Old Westbury, Long Island, N. Y., was formally dedicated as a public botanical garden and arboretum on July 2, 1959.

The 70-acre tract, encompassing four formal gardens, as well as broad allees of linden and beech trees, informal gardens, numerous old specimen trees, and artificial and natural lakes and pools, was donated to Old Westbury Gardens, Inc. by the John S. Phipps Foundation to foster public interest in horticulture and preserve the half-century-old plantings for the enjoyment of future generations. Old Westbury Gardens also includes the 30-room Westbury House, one of the finest examples of Georgian architecture in the eastern United States. The ground floor of the mansion will be open as a museum for the first time this year, 1960.

The formal gardens, designed by the famous English architect George Crawley in 1906 and carefully cultivated under the supervision of the late Mrs. John S. Phipps for almost 50 years, include a circular rose garden; a walled Italian garden of fruit trees; a boxwood garden, and a lily pond.

In addition, there are informal gardens, natural pools, and gently rolling land rich in shrubs and towering old trees. According to the Long Island Horticultural Society, the trees include the largest of their kind on the Island—red maple, weeping purple beech, weeping flowering

dogwood, star magnolia, white pine, dwarf hinoki cypress, and a brittle willow considered to be the largest in the country.

Participating in the dedication ceremonies were Robert Moses, Chairman of the Long Island State Park Commission and Commissioner of Parks of the City of New York, A. Holly Patterson, Nassau County Executive, Dr. George S. Avery, Director of the Brooklyn Botanic Garden, and Mrs. Etienne Boegner. Mrs. Boegner, daughter of the late Mr. and Mrs. John S. Phipps, is president of Old Westbury Gardens, Inc., the non-profit organization that will operate the gardens.

Located about 20 miles east of New York City, Old Westbury Gardens may be reached by automobile on either the Grand Central-Northern State Parkway or the Long Island Expressway, or by Long Island Rail Road to Westbury and by cab from the station.

The Gardens and lower floor of the House will be open Wednesdays through Sundays, May 1 to October 15, from 10 A.M. to 5 P.M.
Admission:
Gardens, $1.25
House, 75¢
Special fees for groups

A vista from one of the pergolas in the walled Italian garden. The borders along the walks are kept in continual bloom by filling spaces between bulbs and perennials with annuals and bedding plants

Temple of Love offers a fine view of one of the tree-bordered lakes in Old Westbury Gardens. The stone circular summer house, brought over from England, is one of several in the half-century-old-gardens

NEW BONSAI FOR THE BROOKLYN BOTANIC GARDEN COLLECTION

A RECENT gift to the Garden has made possible the acquisition of four new bonsai from Japan. They were grown in sphagnum moss for a season before shipping, and were packed in moist sphagnum in ventilated cases for shipment to New York. The SS. Tsuneshima Maru of the Iino Lines, on which they came over, left Yokahama on January 10, arriving in New York on February 11. The specimens were dormant when shipped, but buds of the wisteria and pomegranate sent out new shoots in transit; being in a dark hold of the ship (but watered from time to time) the new 2- to 3-inch-long shoots were spindly and white in appearance. On February 13, the bonsai were taken to Hoboken, New Jersey, to the Plant Importations Branch of the Plant Quarantine Division of the U. S. Department of Agriculture. On Monday, the 15, they were fumigated with methyl bromide for two hours at a concentration of 2 pounds methyl bromide per thousand cubic feet. Temperature 70° F. This is the standard concentration for fumigating greenhouses.

The sphagnum was around the main trunk, as well as the roots, and was not removed during fumigation. It was slightly moist.

After fumigation the bonsai were transported to the Botanic Garden, and two hours later were potted in soil in the containers shown.

Fumigation always seems experimental, at best, but this was carried out under the most favorable conditions possible, and survival is indicated for all but the cryptomeria. More about this next year. Meanwhile, those who are interested in growing bonsai should read the Handbook on Bonsai (*See back cover*).

(*Continued on next page*)

A forty-year-old wisteria

This twenty-five-year-old cryptomeria looked sick three weeks after fumigation

Above, a half-century-old pomegranate; *below*, a half-century-old dwarf azalea. All plants are in the Mr. and Mrs. Edward L. Holsten collection

Buhle photos

WORTH READING

A Supplementary List of Significant Articles Published During 1959

A New Answer to an Old Need, by Richard E. Klinck. *National Parks Magazine,* September. The usefulness of national parks as a great outdoor classroom.

A Wildlife Sanctuary for Your Community, by George H. Breiding. *Audubon Magazine,* March-April. Helpful suggestions for clubs and civic groups on how to establish a local sanctuary.

How Can We Save the Wildflowers? by Helen S. Hull. *Audubon Magazine,* May-June. A program for saving wildflowers from destruction, beginning with a home wildflower garden.

The Production of New Flower Varieties, by Clark D. Paris. *The National Horticultural Magazine,* July. What it takes to breed a new hybrid annual flower.

Chemistry in Plant Societies, by James Bonner. *Natural History,* November. Plants cooperate or compete with neighbors for growth essentials; but they act on each other chemically, too.

Chemistry of Growth in Plants, by Anton Lang. *Natural History,* March. Plants, like animals, produce hormones vital to their growth. Such a substance is gibberellin.

Glen Helen's Fight for Survival, by Kenneth W. Hunt. *American Forests,* November. The story of how one community undertook to preserve and utilize a forest tract.

Japanese Gardens, by Tatsuo Ishimoto. *Flower Grower,* November. An illustrated feature on various aspects of Japanese gardens, including gates, fences, paths, lanterns and water-basins; one section of an issue devoted to Japanese gardening.

The Toad, by Picasso, an illustration from "The Gardener's World", edited by Joseph Wood Krutch (G. P. Putnam's Sons)

The Control of Plant Diseases by Chemotherapy, by J. E. Livingston and M. T. Hilborn. *Economic Botany,* January-March. An exhaustive summary, with bibliography, of plant disease control with chemotherapeutic chemicals.

Lichens, by I. Mackenzie Lamb. *Scientific American,* October. Humble organisms, fungi and algae, which together are able to survive in some of the harshest environments on earth.

The Best Seventy Lilacs, by Donald Wyman. *American Nurseryman,* June 1. The top ranking varieties in the collection of the Arnold Arboretum.

Plastic Covers for Early Tomatoes, by R. E. Wester. *Flower & Garden Magazine,* April. A report on government research with plastics and other frost-protection materials.

Foliage and Flower in Church Landscaping, by Victor Otto. *Horticulture,* December. The principles of landscaping church grounds.

Underground Greenhouse, by John Caskey. *Flower Grower,* September. An amateur's experience in building and managing a plastic-roofed pithouse.

Light Up the Outdoors, by D. Newton Glick. *Flower Grower,* May. Principles of garden lighting, and methods of placing equipment.

Bright Ideas for Shade, by Bernice G. Brilmayer. *Popular Gardening,* July. Directions for building various types of lath houses.

The How and Why of Training Trees, by John K. B. Cowley. *Popular Gardening,* September. How to ensure straight trunks and leaders (if wanted) by training trees while they are young.

Prisoner's Escape, by Robert Neese. *Flower Grower,* August. The story of how a gift of a gloxinia plant started a group of prisoners in the hobby of gardening.

Some Bulbs of the Middle East, by O. Polunin. *Gardeners Chronicle* (England), February 28 and March 21. A personal account of observing and collecting bulbs in the Middle East.

Reblooming Iris, by Edwin Rundlett. *The Garden Journal,* May-June. The story of the development of a whole new race of iris which bloom twice a year.

Collecting Irises Abroad, by L. F. and Fannie R. Randolph. *Bulletin* of the American Iris Society, October. The experiences of two of the world's foremost authorities on species iris in securing rare iris for their famous collection in Ithaca, New York.

Box Come Tailored for Many Climates, by H. Gleason Mattoon. *Horticulture,* April. Adaptability of different kinds of box to climatic zones, and the care they need.

Selected Bulletins

Growing Chrysanthemums in the Home Garden, Home and Garden Bulletin 65. Superintendent of Documents, Washington 25, D. C. 8 pp. 5 cents.

General instructions in growing chrysanthemums outdoors.

Plant Explorations. Agricultural Research Service, U. S. Department of Agriculture, Beltsville, Md. in cooperation with Longwood Gardens. 180 pp. (Distribution limited to research workers.)

A directory to noteworthy ornamental plants now growing in private gardens, botanic gardens, experiment stations and arboretums in Italy, Southern France, Spain, Portugal, England and Scotland.

Orchid Culture, by Robert J. Gillespie. Missouri Botanical Garden Bulletin. Vol. 47, No. 1, St. Louis 10, Mo. 23 pp.

A basic guide to the culture of the major types of orchids.

Succulents, by Ladislaus Cutak. Missouri Botanical Garden Bulletin Vol. 47, No. 4. St. Louis, Mo. 27 pp.

The culture of succulents, both indoors and out, and their propagation.

Eastern Hemlock Growth Cycle and Early Years, by Jerry S. Olson, Forest W. Stearns and Hans Nienstaedt. Circular 205. Connecticut Agricultural Experiment Station, New Haven. 24 pp.

A study of the effects of light, temperature and nutrients on seedling hemlocks.

Ornamental Vines for Florida, by R. D. Dickey, Erdman West and Harold Mowry. Bull. 172. Agricultural Extension Service, Gainesville, Fla. 72 pp.

The culture and care of vines suitable to Florida and mild climate gardens; an alphabetical descriptive list. Illus.

Blueberry Growing, by John S. Biley and Joseph L. Kelley. Publication 240. University of Massachusetts, Amherst. 20 pp.

Planting, care, and pest control of blueberries.

Insects of Evergreen Trees and Shrubs, by Robert E. Treece and Clyde C. Hamilton. Ext. Bull. 321. College of Agriculture, New Brunswick, N. J. 16 pp.

One in a series of six bulletins, illustrated in color, on major insect pests in New Jersey.

Insects of Ornamental Trees and Shrubs in Rhode Island, by T. W. Kerr. Bulletin 348, Agricultural Experiment Station, Kingston, R. I. 55 pp.

Pests grouped according to the host plant; described, and control noted.

Strawberry Diseases, Farmers' Bulletin, No. 2140. Superintendent of Documents, Washington 25, D. C. 24 pp. 15 cents.

The symptoms, distribution and control of strawberry diseases.

Lawn Diseases in Arizona, by Alice M. Boyle. Technical Bulletin 136. University of Arizona, Tuscon, Ariz. 16 pp.

Symptoms of lawn diseases and control measures.

The Black Widow and Five Other Venomous Spiders in the United States, by W. J. Baerg. Bull. 608. University of Arkansas, Fayetteville, Ark. 44 pp.

Complete data on habit, venomous nature, extermination of each spider.

Ridding the Garden of Common Pests, Circular 479. University of California, Berkeley Calif. 48 pp.

A guide to the identification of common garden pests, particularly on the West Coast, and their control.

Chemical Control of Weeds and Brush Along Roadsides, by John F. Ahrens. Bull. 624. Connecticut Agricultural Experiment Station, New Haven. 32 pp.

A technical bulletin on materials to use, and methods of application.

Diseases and Other Disorders of Turf, by Raymond J. Lukens and Ernest M. Stoddard. Circular 208. Connecticut Agricultural Experiment Station, New Haven. 12 pp.

How to identify and control lawn diseases.

Gardeners' Training Scheme, worked out by the Department of Horticulture, Government of Mysore (India). 36 pp.

This bulletin describes a project started in 1952 for Indian children and adults at the Government Gardens in Mysore. It includes a syllabus for a six-month gardeners' training course. Interesting to anyone trying to get a world view of gardening and horticultural education. Obtainable from Office of the Superintendent, Government Gardens in Mysore, Lalbagh, Baugalore, South India.

Rootstocks and Methods Used for Dwarfing Fruit Trees, by K. D. Brase and R. D. Way. Bull. 783. Agricultural Experiment Station, Geneva, N. Y. 50 pp.

A technical bulletin on rootstocks suitable for producing dwarf fruit trees.

Successful Rose Culture, by Glenn O. Randall, Howard R. Garriss, and H. E. Scott. Ext. Circular 200. Agricultural Extension Service, Raleigh, N. C. 24 pp.

Culture of roses, and selection of varieties suited to the Carolinas.

Growing Better House Plants, by Alfred J. Gianfagna and James K. Rathcell, Jr. Circ. 491. Pennsylvania State University, University Park, Pa. 32 pp.

Good plants suited to indoor culture, and their care.

Tree Diseases, Description and Control, by Lester P. Nichols. Circ. 46. Pennsylvania State University, University Park, Pa. 20 pp.

Common diseases of ornamental trees, their diagnosis and control. Illus.

Outstanding Garden Books of the Year

Plant Propagation: Principles and Practices, by Hudson T. Hartmann and Dale E. Koster. Prentice-Hall, Englewood Cliffs, N. J. 559 pp. $8.75.

Here in one volume is encyclopedic coverage of both the theoretical aspects and practical techniques for propagating almost every kind of plant. Methods include seedage and various vegetative processes. This book is useful either for reference or as a teacher's manual.

Adventures in Nature, by Edwin Way Teale. Dodd, Mead, N. Y. 304 pp. $4.00.

Thirty-one selections from six previous books have been gathered together in this volume as a distillation of some of the finest chapters ever written by one of America's most sensitive naturalists.

10,000 Garden Questions, Answered by 20 Experts. Edited by F. F. Rockwell. Doubleday & Co., N. Y. 1390 pp., over 400 illustrations. $5.95.

This is a revised and expanded edition of a book intended to answer the average home gardener's questions on every conceivable subject. Questions with their answers are grouped under major headings, such as soils and fertilizers, ornamental plants and their culture, lawns, house plants, etc. There is a 60 page index to the text.

The Natural Thing, by Pieter W. Fosburgh. Macmillan Co., N. Y. 255 pp. $4.75.

A collection of essays, written by one deeply interested in conservation, which will have special appeal to nature lovers.

The Garden Flowers of China, by H. L. Li. Ronald Press, N. Y. 240 pp. $6.50.

In this book one finds gathered together a wealth of material on the legends and history of scores of important Chinese garden flowers, many of which have been in cultivation for more than one thousand years. Among the flowers are the tree peony, chrysanthemum, camellia, rose, day lily, magnolia and azalea. There are separate chapters on flowering trees, shrubs, herbs and vines, and also one on recent introductions. An index to Chinese plant names is appended.

Garden Ideas and Projects, edited by Richard D. Whittemore. Doubleday & Co., Garden City, N. Y. 532 pp. $3.95.

Under seven general headings, such as tools and equipment, special gardens, projects with wood, etc., scores of things to make for the garden and jobs to do are covered concisely in text and line drawings. Major sections of the book are titled: 500 common garden mistakes corrected; a practical calendar for home gardeners; a self-pronouncing dictionary of plant names.

The Arboretums and Botanical Gardens of North America, compiled by Donald Wyman. Published by The Arnold Arboretum of Harvard University, Jamaica Plain 30, Mass. 69 pp. $1.50.

A directory to these 109 gardens, listing chief function, special features, data on their administration, facilities, etc.

Thousand Acre Marsh, by Dudley Cammett Lunt, Macmillan Co., N. Y. 174 pp. $3.75.

The author, a naturalist, has recorded, in a sensitive manner, those moments and incidents which, over the years since boyhood, have come to be so much a part of his way of life.

Polythene Film in Horticulture, by Henry R. Spice. Faber and Faber, London. 176 pp. 18/0.

A review of the various uses of plastic film in plant culture, from making greenhouse structures to mulching.

The Power of Prayer on Plants, by Rev. Franklin Loehr. Doubleday & Co., Garden City, N. Y. 144 pp. $3.50.

A report on exploration to discover tangible results of the effect of prayer upon growing plants. Trained scientific investigators will question methods, and therefore many of the results reported.

The Gardener's World, edited by Joseph Wood Krutch. G. P. Putnam's Sons, N. Y. 476 pp. $8.95.

Some of the greatest examples of the literature of plant lore and gardening—128 in all—have been assembled by the author to tell the story of man's love of nature and plants. The selections cover every aspect of the natural world, as indicated by the great range of sources which include John Evelyn, Linnaeus, Virgil, John Burroughs, Thoreau and Edwin Way Teale. Full-page duatone plates reproduce the works of great artists.

Exhibitors and Judges Handbook, by Clara May Frederick and Lee Merz. The Ohio Association of Garden Clubs, 145 Tanglewood Dr., Urbana, Ohio. 136 pp. $2.50.

Complete directions for planning and staging flower shows; exhibiting plants, flowers and arrangements; and judging all types of exhibits.

Home and Garden Calendar, 1960. Hearthside Press, N. Y. 112 pp. $1.00

A spiral-bound date book, consisting of full-page illustrations of arrangements made mostly by garden club experts pictured in black and white. Each is briefly described, and there is a facing weekly engagement calendar page.

Your Lawn, How to Make It and Keep It, by R. Milton Carleton. D. Van Nostrand Co., Princeton, N. J. 166 pp. $3.95.

Lawn maintenance has been brought up to date to keep pace with current developments, based on scientific research, in lawn weed and pest control, fertilization, lawn grass selection, and general maintenance.

Gardening for Gourmets, by Ruth A. Matson. Doubleday & Co., Garden City, N. Y. 262 pp. $3.95.

This beautifully written book is for all who like to eat well and who relish the freshness and peak-of-perfection taste of vegetables and fruits grown in their gardens. Fifty tempting recipes are in the final chapter.

Common Edible Mushrooms, by Clyde M. Christensen. Charles T. Branford Co., Newton Centre 59, Mass. 124 pp. $3.50.

By means of illustrations and descriptions, over 60 native mushrooms are identified, and their cookery described. Originally published by the University of Minnesota Press.

Index to Common Names of Herbaceous Plants, by R. Milton Carleton. G. K. Hall & Co., Boston. 130 pp. $10.00.

In this list that runs from Aaron to zig-zag clover, the author has attempted to list the thousands of common plant names of herbaceous plants now in use throughout the country, and to relate them to the proper genus. There is no attempt to assign approved names to plants, and many vernacular names, including those current in the Kentucky Mountains and the great Smokies, are given. The one weakness in this book is that there are no cross-references from botanical names to common names. Thus, one cannot find, easily, all the common names that refer to any given plant.

Raising Vegetables, by George W. Ware and J. P. McCollum. Interstate Printers and Publishers, Danville, Ill. 460 pp. $6.50.

This textbook is intended principally as a guide to the various phases of vegetable growing with emphasis on special crop production and marketing. College and vocational schools, and commercial growers will find it to be of special value to them.

101 American Wild Flowers, by Jewell Casey. Vantage Press, N. Y. 102 pp. $3.00.

This book, in which over one hundred wild flowers native in the Southwest are described and pictured, is intended primarily as a source of data and interesting facts which will be useful to teachers and lovers of wild flowers.

GARDEN FLOWERS AND PLANTS

Garden Irises, edited by L. F. Randolph. Published by the American Iris Society, St. Louis, Mo. 575 pp. $7.95.

Fifty-two experts of Great Britain and the United States are contributors to this fine book in which is brought together complete information on iris culture. Subjects covered include the history of iris, landscape uses, propagation, pest identification and control, breeding, exhibiting and judging. There are separate chapters on every class of iris. This is an indispensable book for the iris enthusiast.

Easy Ways to a Beautiful Garden, by Ruth Gannon. The Viking Press, N. Y. 165 pp. $5.00.

Home gardeners with limited time and those just starting a garden will find much help in this book in planning, preparing and selecting bulbs, annuals, perennials, roses, shrubs and small flowering trees. Many basic lists of plants are given, in some cases keyed to planting plans. There are many illustrations.

Herbs, How to Grow Them and How to Use Them, by Helen Noyes Webster. Charles T. Branford Co., Newton 59, Mass. 204 pp. $3.50.

A revised edition, complete with chapters ranging from early period herb garden design to a check list of herbs for modern gardens. To this edition has been added a chapter on fragrant and bitter herbs of the Bible.

American Rose Annual 1959. Published by the American Rose Society, Columbus 14, Ohio. 266 pp. $4.50.

In the 40-odd articles in this annual, there is a full range of rose topics, of special interest to amateur growers, including variety performance, pest control, hardiness, and growing roses for exhibition. A major feature is the "proof of the pudding" section—an appraisal of recently introduced roses by scores of rose testers.

Old Roses for Modern Gardens, by Richard Thomson. D. Van Nostrand Co., Princeton, N. J. 154 pp. $7.50.

This book is a personal appraisal of old roses, for rather than fill the chapters with the names of all the moss, China, tea, noisette, hybrid perpetual, gallica and other treasured old varieties, the author has chosen to confine his remarks to the ones he has grown or observed. Considerable historical data are given.

Daffodils, Outdoors and In, by Carey E. Quinn. Hearthside Press, N. Y. 204 pp. $4.50.

Anyone inclined toward gaining a better understanding of daffodils will welcome this book which includes many topics beyond basic cultural data, such as indoor forcing, arranging the flowers, exhibiting at shows, regional performance of varieties, and daffodil breeding.

Peonies Outdoors and In, by Arno & Irene Nehrling. Hearthside Press, N. Y. 288 pp. $5.95.

The long and colorful history of the peony has been brought up to date in this book, including a complete listing of all varieties registered with the American Peony Society during the last half-century. Every conceivable phase of peony culture, use in the garden, variety selection for special purposes, propagation is included for both the herbaceous and tree varieties. An important section of the book deals with the use of cut peonies indoors and exhibiting and judging them at flower shows.

A California Flora, by Philip A. Munz and David D. Keck. University of California Press, Berkeley, Calif. 1682 pp. $11.50.

In this comprehensive manual, both native and naturalized plants of California are included. Descriptions give habitats, plant communities, altitudinal and geographic distribution, flowering dates and chromosome numbers where known. There is an important section on the early geological history of the state and the fossil floras.

Three 32-page, paper-bound booklets by Gertrude B. Foster, available for $1.25 each, are available from The Herb Grower Magazine, Falls Village, Conn. They are:

Herbs, Our Heritage; suitable herbs for Colonial gardens.

A Baker's Dozen Herbs; herbs used in seasoning bakery products, and how to grow them.

A Score of Easy Herbs; seasoning herbs, their culture and harvesting methods.

Landscaping With Vines, by Frances Howard. Macmillan Co., N. Y. 230 pp. $6.50.

The brief first section of this book deals with the many uses for vines. The rest is given to descriptions of 350 species, in which complete data including hardiness range are given. There are numerous line and halftone illustrations.

Perennials in the Garden, by Charles H. Potter. Criterion Press, N. Y. 271 pp. $6.95.

This is a solid handbook on growing and selecting herbaceous perennials. The first section of the book is given over to all phases of culture. In the second section, specific data are given for 160 kinds of perennials.

Encyclopaedia of Chrysanthemums, by Monica Bennett. (1958) Pitman Publishing Corp., N. Y. 194 pp. $5.95.

An experienced English grower and exhibitor shares her knowledge in a manner directed toward amateur chrysanthemum fanciers. Although varieties and cultural methods in this book are best suited to England, American readers can benefit from many of the chapters.

Annual and Biennial Flowers, by A. P. Balfour. Penguin Books, Inc., Baltimore 11, Md. 262 pp. $1.50.

Practical instructions are supplied for raising scores of annuals and biennials both in the garden and the little greenhouse. There are 150 photographic reproductions in this paper-bound book.

Flower-Growing for Shows, by E. R. Janes. Penguin Books, Inc., Baltimore 11, Md. 224 pp. $1.25.

Crammed between the paper covers of this little book are complete data on growing, cutting, packing and staging the flowers of 52 different annuals, perennials and bulbs, plus other information useful to exhibitors. Written by one of England's foremost showmen. There are 155 line drawings.

Daylilies for Every Garden, by G. M. Fosler and J. R. Kamp. University of Illinois, Urbana, Ill. 72 pp. 50 cents. A revised edition.

Steps required to grow daylilies and ways to use them in the garden are covered in this bulletin.

Rock Garden Plants, by Doretta Klaber. Henry Holt & Co., N. Y. 174 pp. $3.95.

The author proposes that many plants, usually considered suitable only for rock gardens, should be grown in other locations in the garden. Nearly 400 kinds are described, alphabetically, and their culture given.

Camellias for Everyone, by Claude Chidamian. Doubleday & Co., Garden City, N. Y. 191 pp. $3.95.

The author first traces the history of camellias, and in following chapters gives simple instructions on how to grow them, in a greenhouse or outdoors, and how to start a collection. There are numerous black and white and color illustrations.

Trees and Shrubs

Ornamental Crab Apples, by Arie F. den Boer. Published by the American Association of Nurserymen, Washington, D. C. 226 pp. $4.95.

Brought together within this book is everything one needs to know about ornamental crab apples; their use, qualities, form, foliage, flowers, fruit and care. The major section of this book is an alphabetical descriptive list of all worthwhile species and varieties. Many line drawings are helpful in identification. Mr. den Boer is internationally known for his planting of crab apples in Charles Sing Denman Woods, Des Moines, Iowa.

Tree Maintenance, by P. P. Pirone. Oxford University Press, N. Y. 483 pp. $10.00.

In this revised and enlarged third edition, the author has gathered together the latest information on tree care based on 20 years of research and observation. Within the sections on general maintenance, diagnosing tree troubles and identification of specific pests of scores of different trees, every known ill of trees, and up-to-date control measures for each one, are given.

Evergreens for Every State, by Katharine M-P. Cloud. Chilton Co., Philadelphia. (1960). 228 pp. 82 illus. $4.95.

The use, selection and care of both tender and hardy evergreen trees and shrubs is broadly covered in this comprehensive book. Introductory chapters on training evergreens in various forms, their propagation and general care, are followed by an alphabetical guide to about 500 different kinds with descriptive data. The last section of the book is devoted to reports by experts in all states and Canada on evergreen care and lists of desirable kinds for their climate.

American Camellia Yearbook. Published by the American Camellia Society, Gainesville, Fla. 388 pp. $6.00 with membership in the Society.

In this annual, which is dedicated to Ralph S. Peer who very recently died, are several dozen articles, written by both amateur and professional camellia experts, on many aspects of species and varieties, their general culture, grafting, pruning and pest control. There are numerous black and white and color illustrations.

1001 Questions Answered About Trees, by Rutherford Platt. Dodd, Mead, N. Y. 318 pp. $6.00.

By means of questions and concise answers, the author supplies a vast amount of information about trees and tree products. The questions are grouped under the headings: history and facts; forestry; house trees; tree products; tree pests and diseases; the tree as a living thing. There is a complete index.

Flower Arrangement and Indoor Gardening

Design for Flower Arrangers, by Dorothy W. Riester. D. Van Nostrand Co., Princeton, N. J. 174 pp. $7.50.

This is a most stimulating book on flower arranging. The author, a noted sculptor, relates many art forms to arranging—such as architecture, painting, sculpture and nature, with the intent to show how to feel and think design, how to understand it, and then how to create flower arrangements based on its sound principles. The emphasis throughout is on design. Workshop exercises at the end of each chapter offer many ideas for club programs. There are over 100 illustrations.

How to Make Money from Your Home Greenhouse, by Peggie Schulz. D. Van Nostrand Co., Princeton, N. J. 87 illus. 324 pp. $5.95.

The text of this book is just as straightforward as its title. The author has based the contents on her experience and that of many other small greenhouse owners, and has

assembled a vast storehouse of information on how to build and run a small greenhouse, kinds of plants to grow profitably, sales methods and money making ideas. Cultural methods for many kinds of greenhouse plants are included.

Modern Art in Flower Arrangement, by Emma Hodkinson Cyphers. Hearthside Press, N. Y. 123 pp. $4.50.

This book was written to establish the place and influence of modern art in flower arrangement. There are 66 photographic reproductions of stimulating examples of modern arrangements. The emphasis throughout is on the use of structure and design in arrangements as a means of personal expressiveness.

A Treasury of Rose Arrangements and Recipes, by Julia Clements. Hearthside Press, N. Y. 88 pp. $3.50.

A generous supply of photographic reproductions, a number of which are in step-by-step sequences, offers inspiration in the tasteful arrangement of cut roses indoors. There is a chapter on the use of rose flowers and fruits for pot-pourris, preserves and the like.

Design With Flowers—Unlimited, by Patricia Kroh. Doubleday & Co., Garden City, N. Y. 141 pp. $4.95.

Readers of this book are encouraged to create new designs in their arrangements of flowers and plant material. The principles of design and color harmony are effectively discussed. There are 71 black and white and 21 color illustrations.

Religious Themes in Flower Arrangement, by Ruth E. Mullins. Hearthside Press, N. Y. 122 pp. $5.95.

Arrangements suited to various religious services, and also to different religions, are presented in 62 black and white and 12 color illustrations, with explanatory text.

Flowers Around the Clock, by Seiko Hara. David McKay Co., N. Y. 147 pp. $4.95.

Though the author studied flower arrangement under a Japanese master, her arrangements follow a "free style" which gives them great charm and originality. Dozens of arrangements, each beautifully pictured on a large-size page, are supplemented by drawings which show the actual placement of all material in terms of the hours shown on the face of a clock. This novel plan gave rise to the title of the book. The reproductions in both color and black and white are excellent. (Printed in Japan.)

Stepping Stones to Japanese Floral Art, by Rachel E. Carr. David McKay Co., N. Y. 116 pp. Sixth revised edition. $4.95.

This is a basic guide to conventional styles of Japanese flower arrangement, beginning with historic notes, then data on cutting and handling plant material. In the last half of the book, two facing pages are devoted to each arrangement to show the finished piece and also sketches of each stem, leaf, and flower and the placement indicated in a numbered diagram.

The Effective Use of House Plants, by Corry Van Alphen. Emerson Books, N. Y. 96 pp. $2.95.

The ideas presented in 96 photographs and the text originate primarily from English and European sources. Plant culture and variety selection for various exposures indoors are applicable in general in this country.

Flower Arranging for Fun, by Hazel Peckinpaugh Dunlop. The Viking Press, N. Y. 120 pp. $4.95.

By means of ten step-by-step illustrated projects, and pictures of many more finished arrangements, the basic principles of comparatively simple flower arrangement are presented.

Orchids for Home and Garden, by T. A. Fennell, Jr. Rinehart & Co., N. Y. 160 pp. $3.95.

This book is designed to help beginners to start an orchid collection, and to succeed with them in the window, greenhouse, or outdoors in the South. A revision of an earlier edition.

The Flower Arrangement Calendar 1960, by Helen Van Pelt Wilson. M. Barrows & Co., New York. 60 pp. $1.50.

A weekly engagement calendar illustrated with a photographic reproduction of a flower arrangement, with descriptive text, opposite each weekly calendar page.

Popular Styles of Japanese Flower Arrangement, by Lida Webb. Hearthside Press. N. Y. 128 pp. $2.95.

This is a guide to the basic characteristics of all the major schools of Japanese flower arrangement. Numerous line drawings illustrate the text. Flower show exhibitors will find this book of special usefulness.

Exotica 2, Pictorial Cyclopedia of Indoor Plants, by Alfred Byrd Graf. Roehrs Co., Rutherford, N. J. 1149 pp., 7600 illustrations. $25.00.

More than 2000 kinds of plants have been added to the second edition of this book which was first published about a year ago. Twelve additional pages of color illustrations and errors in plant names corrected. This is an exhaustive guide to tropical and subtropical ornamental plants, their culture and use.

The Cool Greenhouse and Conservatory, by Deenagh Goold-Adams. Faber & Faber, London. 180 pp. $3.50.

Though written for English conditions, American gardeners having cool greenhouses can benefit from this book, particularly from a descriptive list of 200 suitable genera to grow. Tips on culture are included.

Landscape Design

Japanese Gardens for Today, by David H. Engel. Charles E. Tuttle Co., Rutland, Vt. 270 pp. $15.00. (Printed in Japan.)

This book is intended to serve as a guide to landscape architects as well as home owners on the subject of Japanese gardens, their design, relationship to the house, and the inspiration and influence of Japanese design on gardens outside of the Orient. The text is elegantly illustrated with 279 photographic reproductions, mostly of small gardens and details. 70 line drawings, and 17 color plates.

The Book of Landscape Design, by H. Stuart Ortloff and Henry B. Raymore. M. Barrows & Co., N. Y. 316 pp. $3.95.

This is a basic reference covering the history and principles of landscape design, rules of composition for both formal and informal planting, garden furnishings, and community planning and zoning.

Landscaping for Modern Living, edited by Sunset Magazine. Lane Publishing Co., Menlo Park, Calif. 190 pp. $2.00.

A previous edition, "Landscaping for Western Living," has been completely revised to make it applicable to all parts of the country. Solutions to two dozen major landscape problems, such as making a plot plan, arranging the outdoor living area, and use of night lighting, are the body of this book. Copiously illustrated.

Designs for Outdoor Living, by John Burton Brimer. Doubleday & Co., Garden City N. Y. 420 pp. $3.95.

This practical book is crammed with full instructions, and how-to sketches, for making all kinds of fences, walks, pools, trellises, gates, terraces, etc. The amateur craftsman will find much inspiration and guidance here.

Garden Design, by Sylvia Crowe. Hearthside Press, N. Y. 230 pp. $8.95.

Sylvia Crowe, English landscape architect, divides this book into four parts—the history of gardens, the principles of garden design, the materials of design, and creating specialized gardens. The emphasis is strongly on the study of design principles. Most of the many illustrations are of large estates and villas.

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BROOKLYN BOTANIC GARDEN

OF

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES